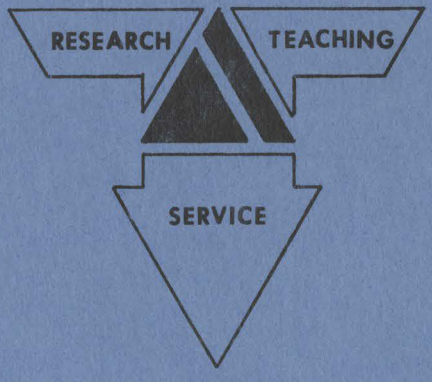
SEQUENTIAL PSYCHOMOTOR DEVELOPMENT OF PRESCHOOL CHILDREN

HOME ECONOMICS CENTER FOR RESEARCH



TECHNICAL REPORT NO. 5
SCHOOL OF HOME ECONOMICS
THE UNIVERSITY OF NORTH CAROLINA AT GREENSBORO

SEQUENTIAL PSYCHOMOTOR DEVELOPMENT OF PRESCHOOL CHILDREN

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Technical Report No. 5
School of Home Economics Center for Research
University of North Carolina at Greensboro
July 1974

ACKNOWLEDGMENTS

Many people because of interest and concern made this study possible. For their help and encouragement, sincere appreciation is expressed to:

Mrs. Sarah Eakins Norris for testing the revised instrument and for sharing the data collected on 98 children. Any conclusions related to that data appearing in this study are those of the senior author--those by Mrs. Norris appear in her Master's thesis.

The consultants for their expertise and advice upon which the study revolved:

Dr. Kate Barrett, School of Health, Physical Education, and Recreation, University of North Carolina at Greensboro
Dr. Carl Cochrane, School of Home Economics, University of North Carolina at Greensboro
Dr. John D. Lawther, Professor Emeritus, Department of Health, Physical Education, and Recreation, Pennsylvania State University
Dr. Roy Moore, Chairman, Department of Health, Physical Education, and Recreation, North Carolina A & T University
Dr. William Powers, Department of Mathematics, University of North Carolina at Greensboro
Miss Marty Van Steenderen, Doctoral Candidate, School of Health, Physical Education, and Recreation, University of North Carolina at Greensboro
Dr. James Watson, School of Home Economics, University of North Carolina at Greensboro

The adults and children of the community and university without whom there would have been no study:

Mr. William Canada, carpenter
Baynes Happy Day Nursery, Mrs. John A. Baynes, Director
Brent Woodson Carter Day Care Center, UNC-G, Dr. Nancy White, Director
Child Development Laboratory, N. C. A & T University, Mrs. Lydia Richardson, Director
Children's House, Bennett College, Mrs. Curry, Director
Experimental Kindergarten, Department of Psychology, UNC-G, Mrs. Marilyn Erickson, Director
United Day Care Services
Administrative staff: Mr. Carl C. Staley, Jr., Mrs. Frances Britton, Mrs. Kathy Stout
Avalon Infant Center, Mrs. Geneva Gilley, Director
Douglas Center, Mrs. Kathleen Thompson, Director
Guilford Center, Mrs. Fay Henry, Director
Ray Warren Center, Mrs. Ann Sprueil, Director
UNC-G Nursery Schools, Dr. Helen Canaday, Director

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The student research assistants who carried the equipment from place to place to test the children and who gave fresh, honest appraisals at every stage of the study:

Miss Rhonda Baker, Junior
Miss Barbara Baldwin, Senior
Miss Susan Blevins, Senior
Miss Patsy Hand, Graduate (worked 2 years)
Mrs. Mary Hardin, Graduate
Mrs. Avis Henderson, Junior
Miss Martha Highsmith, Junior
Mrs. Rachani Lacharoj, Graduate
Miss Sally Nemer, Senior
Miss Jean Pearson, Junior (worked 2 years)
Miss Diane Robinson, Graduate
Mrs. Emily Watson, Graduate

The Research Council of the University of North Carolina at Greensboro for the financial support through two grants: #511 for the original study and #618 for the computer analyses.

Mrs. Nina Curtis for coping with rough copy and idiosyncratic writing.

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BACKGROUND FOR THE STUDY

The Home Economics Center for Research was organized at the end of Spring Semester 1971 to design and initiate a multidisciplinary approach to solving research problems, to teaching research, and to performing community service. The Center proposed to delve into people-oriented research problems by utilizing faculty expertise and interests and by developing the research potential of undergraduate and graduate students (Tech. Report No. 1, Rough Draft). One of the express reasons for undertaking this study was to institute the purposes of the Center for Research by using a research project to involve faculty and students across subject areas, departments, and institutions. The two-year study was made possible through two grants from the Research Council of the University of North Carolina at Greensboro.

The success of the venture in meeting this objective was without question. Participating in the study were:

1. Three institutions of higher education -- all of which allowed the preschool children in their programs to be observed; two provided consultants who assisted with the design of the study; and one planned and directed the study. The institutions varied in size, structure, and racial composition. All were located in Greensboro.

2. Five schools or departments -- Education, Home Economics, Mathematics, Psychology, and Physical Education.

3. Two subject areas in Home Economics--Child Development/Family Relations and Home Economics Education. Six faculty members, some with little research experience, identified the concepts to be studied, developed the equipment, testing procedure, and the observation schedule. One instituted all contacts with the community, trained the observers, and scheduled all observations; another developed the specifics for the directions to the children; and still another assisted in the data analysis.

4. Undergraduate and graduate students were involved at all stages of the research. For example: data were collected by students majoring in Child Development, Home Economics Education, and Interior Design. Several students volunteered to work on the project because they became interested from hearing about it. Data analysis, at one stage, was done by a Clothing and Textiles graduate student. Valuable

suggestions during the development of the testing techniques were made by a doctoral student from Physical Education. A work-study assignee, who was a junior in Child Development, became so interested that she helped develop and pre-test the equipment and then collected much of the data. One undergraduate student who assisted with the testing received permission to report the experience for a paper in General Experimental Psychology.

5. Two graduate students majoring in Child Development continued the exploratory study. One, a Master's candidate assisted in revising the observation instrument and tested the revision with 98 children. The second, a doctoral candidate, used one of the psychomotor tasks from the study as the basis for a research methods class experiment. She was considering development of the problem into a doctoral dissertation.

6. The community. Two organizations, a community-operated day care facility with numerous branches and a commercial day care facility, allowed observation of the children. A highly talented carpenter made the equipment from sketched ideas.

It is the conclusion of the investigator that people can become fascinated in research if they are not frightened by the "ivory tower-white lab coat" approach. Practically everyone has some kind of contribution to make to a research study, and if asked to make a contribution that will give a feeling of success and given help along the way, they will contribute. Further, interest can be maintained by giving progress reports, especially the informal, "Look what our data are showing. This table isn't finished but see what the girls did here . . . and the four-year-olds here . . . ." It takes enthusiasm and patience on the part of the major investigator--and, occasionally pushing people into completing assignments. Without doubt, students become completely involved (and stay interested over an amazingly long period of time), make excellent contributions, and may carry over the effects of the experience into research of their own.

A graduate student in Interior Design made the following evaluation of the experience:

> Being a junior member has meant a great deal to me in many ways. First, I had a feeling of importance and appreciation from the project team. I was included on many decisions and my opinion was sought.

Being able to work with and observe children has been most educational since I had very little experience with children. Being made aware of so many minute details in observation and technique has been outstanding. Although I have been mighty tired of working with the equipment, I would not have missed this opportunity of being a junior member for the world.

I have learned that research is not all glory and fame. It is hard work, often very tiresome and trying of patience. Research requires a million decisions agreed upon by many people, a process which can be most time-consuming. Research requires explicit definitions of terms, concepts, etc. It requires dedication and the ability of making a project one's own for it to be productive, meaningful, and worthwhile to the research. Research requires a team of individuals who can be candid and honest with each other and who are dependable and can take initiative without constant reminders or overseeing. Research is tremendous!

STATEMENT OF THE PROBLEM

Over several decades, generalized descriptions of notor abilities and accomplishments of young children have evolved from the work of such authorities as Gesell, and Ilg and Ames. Studies have been made of how proficient children of varying ages are at specific motor tasks, of how motor skills are best learned, and of how motor skills are best taught. However, specific descriptions of either a general motor ability or of specific motor abilities in the young child have not been defined sufficiently well for either general agreement or for general use. Since the pioneering work of the 1930's there has been a dearth of major studies of the progressive development in movement and movement patterns of young children. Work done at the University of Wisconsin at the Motor Development and Child Study Center (1961) involved photographic records of such movements as the run, the arm throw, and the jump. Keogh's longitudinal study (1968) of limb movement tasks of children aged 5 through 11 in Southern California was done with precision but lacks generalizability because of the limitations imposed by the experimentally accessible population. The 1971 study by Sinclair used task analyses to study movement and movement patterns of 44 normal children two to six years. Means for 18 different tasks were established by age and sex.

The overall purpose of this study was to investigate the sequence(s) in psychomotor development of preschool children. As a starting point for the study, the independent non-university sponsored pilot research undertaken with the University of North Carolina at Greensboro Nursery School children in measurement of motor ability was reviewed. Flinchum (1962), in the Department of Physical Education, identified a series of twelve tests of the motor ability of three and four year olds. The results of the use of

the tests indicated that they might be formed into batteries (p. 43). Singletary (1966), in the School of Home Economics, selected and validated two of the Flinchum test batteries. Both investigators recommended studies for the establishment of motor skill norms for preschool children.

From the review of Piaget's developmental stages a fruitful avenue for study evolved. According to Piaget, young children (age 2-7) have a pattern of behavior arising out of the integration of simpler units into a more complex whole. This pattern or schema is modified by the process of accommodation when coping with new information or new situations. Innumerable studies have been made of children's ability to conserve quantity, weight, substance, number, distance, weight, volume, length, etc. A few studies have undertaken investigation of other aspects of conservation. Pflederer (1964) designed five experiments to measure music conservation skills--conservation of meter, rhythm pattern, melody, tonal series, tonal pattern, and tonality--of children. In 1970, 679 elementary and junior high school pupils were tested for the six aspects of music conservation (Zimmerman, nee Pflederer). The findings indicated that the conservation skills were of varying degree of difficulty (i.e., conservation of meter and rhythm pattern were more difficult than conservation of tonal pattern); and that a plateau in music conservation skills, as measured by the tasks, was reached by the fourth grade. Another group of studies (Price-Williams et al., 1969) concentrated upon the relationship of the role of experience (manipulation) in the attainment of conservation. At two different sites in Mexico, potters' sons were matched for age, education, and socioeconomic class with a control group and given a series of conservation tests--number, liquid, substance, weight, and volume. The potters' sons conserved more frequently on the five tasks. The researchers concluded that the findings suggest "that the role of

skills in cognitive growth may be a very important factor. Manipulation may be a prior and necessary prerequisite in the attainment of conservation, but a skill embodies a set of operations with a recognizable end--making cups from clay for example (p. 769)." From the readings on the concept of conservation, the question arose: If a psychomotor problem-solving task is presented to the child in the preoperational stage, will he be able to conserve--to maintain the invariance of the configuration of that specific task?

The specific objectives of this exploratory study of psychomotor problem-solving behavior of children age 2 through 5 were to:

(1) Describe psychomotor problem-solving behaviors for selected tasks

(2) Determine sequential patterns for gross motor behaviors

(3) Determine relationships between findings and Piaget's concept of development

(4) Establish tentative scales of motor behavior for preschool children at one year intervals.

The psychomotor problem-solving task was defined in the following manner:

> A task to which a number of solutions can be made--ranging from hesitant and uncertain movements indicating that data are being manipulated (problem solving) to the highly skilled, confident performance. (Godfrey & Kephart, 1969, pp. 265-266.)

> A problem-solving task will present a "new" situation to children between the age of 2 and 6. Solution of the problem is an expression of <u>accommodation</u> in the Piagetian sense. The problem will be of sufficient difficulty that the average child at age 2.0 will not be successful but the average child of approximate age 5.5 will be successful.

PROCEDURE

The procedure for the study is reported in much the same sequence as it took place: (1) identifying motor tasks that met the purposes of the study, (2) devising equipment and procedure for testing preschool children, (3) training research assistants to collect the data, (4) revising the observation form after trial use, and (5) selecting subjects. At times the process was extremely slow because so many individuals were involved--often a different mix of individuals at each stage. However, this mix helped achieve an important purpose of the study--involving people in research.

Selection of Motor Tasks

Following a review of motor development, movement and movement patterns, and motor education a series of motor tasks were identified that would present "new" situations to children between the ages of 2 and 6, and could be interpreted in Piagetian terms. Further, the tasks were judged suitable for discerning selected gross movements made by individual children and for discerning patterns of movements made at different ages. The tasks also could be divided into those where the problem was presented to each child by verbal instruction alone and to those where the problem was presented by verbal instruction accompanied by demonstration. The tasks and their sources were:

1. Maintaining balance in forward motion (Godfrey & Kephart, 1969, p. 266)
2. Maintaining balance while moving an object (Godfrey & Kephart, 1969, p. 285)
3. Controlling an object rolled up an incline (Martens, 1971, p. 3)
4. Expressing body image (Godfrey & Kephart, 1969, p. 265)

Each task was then specifically described for the study and criterion established for successful accomplishment or termination. After the trial

runs only one success criterion was changed--that for the Ball Roll. Task descriptions are found in Appendix B.

Testing Equipment

Three elements went into decisions about construction of the equipment used in testing: (1) safety for the children, (2) ease in use, and (3) size and weight for transportation by a woman in a standard 4-door sedan with slightly more than a 60" span behind the driver's seat. More investigation of autos commonly driven by college students might have made some differences in length of the finished pieces but it was possible to transport in a compact.

Testing equipment consisted of:

1. A set of 12 blocks each 2" x 6" x 8" cut from dry wood and sanded smooth. One block had a 3½" circle of yellow pressure sensitive plastic centered on top and on bottom surfaces.

2. An 8 foot hinged board cut from 2" x 8" nonwarped stock. A Soss hinge allowed the two 4' sections to butt and lie flat when opened. A flat door latch placed near one end held the halves closed and a 3½" metal drawer pull provided a sturdy carrying handle. A 1½" strip of black pressure sensitive plastic tape was centered to provide a guide for walking the length of the board.

   Originally marks were placed crosswise of the board to mark each linear foot. However, the expert in physical skills testing requested their removal because he believed the children would gauge their steps by them. During the preliminary part of the study there were numbers marked at each foot of length along the side of the board. All such marks were removed after the trial use.

3. Two inclined plywood targets 60" and 72" in length. 1" x 3" stock framed the sides and top. A 6" hole was centered 12" from the top of each board. A yellow circle 6" wide cut of pressure sensitive plastic was placed around each hole to form a readily visible target. Both front edges were bevelled to lie flat to the floor. A hinged stand 12" high was attached at the top underside of the shorter board; the hinged stand for the longer board placed at the distance from the top to insure the same angle of incline for both boards. Again, the longer board was in two pieces and was hinged on the underside. On the 60" board, the stand was latched to the board with a hook for transporting; the two parts of the longer board were fastened together in the same way and a drawer pull added for carrying.

4. Two sheets of 60# Kraft paper, each approximately 48" x 72". One was used as a standard background for the two tasks performed while the children lay on the floor. The other had a tracing of the placement of the blocks for another task.

The equipment was built by a local carpenter. His understanding of children's behavior and the purposes of the study made it possible for him to take sketches and produce pieces of equipment that met all requirements for testing.

Testing Procedure

Procedure evolved sequentially for each task: (1) establishing task constants (controls), (2) writing and testing instructions, and (3) developing means for recording observations.

Task Constants

In order to have consistent procedures used when testing the children, standards (constants) were established for how a task was begun, what was demonstrated, and/or how equipment was used. For example, two constants were identified for Task V (Balance Board Walk):

(a) Demonstration on floor of how to place feet heel-to-toe

(b) Practice by child prior to walking on board.

Further control was built into the study by specifying that each child should be tested one at a time away from a group, that a set sequence would be followed in presenting the tasks, and how much prompting or encouragement was to be given.

Few changes were made in task constants after the 1972 trial although it was necessary to remove those related to the validation of the body image configurations. One constant for placement of equipment for Task IV (Stepping Stone Walk) was made more specific. The Revised Task Descriptions appear in Appendix B.

Task Instructions

All instructions for testing were developed by the research committee members most experienced in working with small children. All instructions included verbal directions; some also involved demonstration. For those tasks where a motor task was to be demonstrated, the sequence suggested by Lawther (1972, p. 130) was followed: Show: let child try: show again, if necessary. Each set of instructions was written, one or two children tested in front of other committee members and research assistants, and used again until the desired performance could be elicited every time.

Instructions for each of the tasks were typed on 3" x 5" cards for ease in handling; the typing was spaced and sequenced for ease in reading. Each set of cards was stapled together to control the sequence of testing. Instructions for the body image tasks (1972 trial) appear on the next page. Comparisons can be made between them and the revised instructions in Appendix C.

Only minor word changes were made in the instructions following their use in 1972. The investigator who collected the 1973 data suggested changes as she trained to do the testing and all suggestions were used.

Recording Observations

The first stage in developing the instruments for recording observations was to obtain descriptions of generalized movements for all tasks through readings, hypothesizing, and watching a limited number of children in free play situations and in structured situations. The student research assistants were particularily helpful at this stage--making behavior lists, making specific observations, and trying out various formats for recording observations.

1972 INSTRUCTIONS FOR CHILDREN AND REMINDERS TO OBSERVERS

BODY IMAGE

LIE DOWN ON YOUR BACK ON THE PAPER.

MAKE YOURSELF AS BIG AS YOU CAN. (Black pen)

IS THAT AS BIG AS YOU CAN MAKE YOURSELF?

MAKE YOURSELF AS SMALL AS YOU CAN. (Red pen)

IS THAT AS SMALL AS YOU CAN MAKE YOURSELF?

Remember to randomize

Write child's name on paper

Every 5th child will have image traced.

LIE STILL, LET ME MAKE YOUR PICTURE.

Every 5th child will have standard drawn.

NOW, LIE DOWN ON YOUR BACK ON THIS OTHER PIECE OF PAPER. PLACE YOUR HEELS TOGETHER, STRETCH OUT YOUR ARMS. (Straight and both hands on paper)

Mark in black

NOW, SIT UP AND PUT YOUR ARMS AROUND YOUR KNEES.

Mark in red

The second stage was to establish observation standards for each task. For example, the observation for the Serpentine Path (Task III) was established as:

(a) Upper body movements to maintain balance
(b) Placement of feet during walk
    . Alternating placement (stride)
    . Trailing foot brought to lead foot on same block
    . Missteps
(c) Accuracy of walk
    . Number of blocks stepped on (single foot, both feet at a time)
    . "Short cuts" taken
    . Turn before return

Some of the standards were made more specific after the trial use in 1972. The revised standards appear with task descriptions in Appendix B.

The last stage was to develop the format for the instrument. Each behavior observation form consisted of three sections of check lists: upper body movements (gross or specific); lower body movements (mainly foot movements); and estimations of how progress would be made through the task. Diagrams were provided for two tasks. Space was provided for writing descriptions of behaviors not listed and for recording refusals.

When possible, the checklists were placed on the right half of an 8½" x 11" paper turned sideways. It was possible to place the checklists for both body image observations and for both ball roll observations on one page. Each of the five pages of the form was reproduced on paper of a different color. Observers used clipboards for a writing surface during testing. Revised observation forms appear in Appendix C.

A second form, for recording demographic information about each child, contained blanks for the child's name, place of testing, and seven other types of information: sex, age in years and months, birth order, ethnic group, father's occupation, length of time child had been in an organized preschool education center, height in inches, and weight in pounds. In

addition, blanks were provided for the date of testing and the names of the research assistants who tested the child. These data were held confidential and only the senior researchers were authorized to obtain the data.

Two items were not useful as obtained--age and length of time in an organized center. Information gained about the latter was so vague as to be meaningless. The data should be ignored especially if testing at public day-care facilities. Information about age should be recorded as "date of birth" which would allow more rapid completion of the form; conversion into age groupings would then easily be accomplished using arbitrary classification.

Training Research Assistants

Printed "Instructions to Research Assistants" were developed for use with the students who were trained in 1972 to collect data and for use in explaining the study to cooperating agencies and other groups. The "Instructions" included the purposes of the study, described the testing and the training procedure, suggested ways to work with the children, and described the psychomotor problem-solving tasks. In 1973 the materials were revised before training a second group of research assistants. The revised materials are found in Appendices A and B.

The training procedure followed much the same pattern in 1972 and 1973. Research assistants (1) attended a session at which the study was explained and administration of each test demonstrated, (2) practiced with another college student to familiarize selves with the instructions and equipment, (3) practiced with another college student administering (or observing) the tests to several children individually until testing and recording of observations were done with consistency and ease, and

(4) tested two or three children individually under standard conditions to receive approval to collect data.

In 1972 eight female research assistants were trained to test and observe. Factors of scheduling, the impending end of the school year, and money influenced the decision to prepare the research assistants to work in teams of two who would alternate in administering the test and who would be able to accurately observe and record both the upper body movements and the lower body movements. Specific directions were given to this group for randomizing sequence in presenting the four tasks where sequence effect was under study and for handling the three completed data forms for each child (each observer completed a separate observation form). One member of the research committee scheduled training, found a place where the equipment could be placed for practice sessions, approved proficiency, scheduled the testing of all the preschool children, and obtained the demographic data for each child.

In 1973 stricter control was placed over the testing: only one individual was trained to test, and two research assistants observed at each testing session. The Master's candidate continuing the study as a thesis did all testing. Four female research assistants were trained by the senior investigator at the same time and at the site where the major portion of the testing would take place. After they had practiced sufficiently, they were approved as observers when 100% agreement with the senior investigator was reached for every task observation.

Because students were given the responsibility of collecting data off campus and at different places on campus, a checklist was developed to assist them in organizing the equipment and materials needed for each testing session. In condensed form, the list follows:

Before you leave campus, check to see that you have everything you will need for testing and observation.

Be sure to get directions for getting to site of testing.

Checklist for equipment:
- Long board
- Short board
- Balance board
- Block stool
- Scales
- Blocks
- Balls (3)
- Serpentine path pattern (paper)
- 1 piece Kraft paper

Kit (beach bag) checklist:
- Task directions cards
- Demographic forms
- Instructions for observers
- Observation forms
- 2 clip boards
- Pencils (and pens, if needed)
- Tape measure
- Masking tape
- Paper towels
- Kleenex
- Plastic bags

Selection of Subjects

Subjects were children enrolled in private and public preschool facilities in Greensboro, North Carolina. These facilities included all child care centers at each of three institutions of high education, day care facilities selected from those operated under United Funds, and one large commercial establishment. Exclusions from the study were only those made by administrative decision at a few of the day care facilities (quota sampling was permitted) or by absence. Children were selected insofar as possible to achieve a sample representative of the preschool child--to achieve balance among age groups and between sexes, ethnic backgrounds, and socio-economic levels. There were 52 2-year olds (19.3%), 66 3-year olds (24.4%), 4-year olds (27.8%), and 77 5-year olds (28.5%). Of the total group 55.9% were male, 63.7% white, and 55.6% from the upper socio-economic level.

Parents or other adults responsible for the children to be tested were asked to sign and return the following simple permission form:

> The children will be observed for their ability to do certain things such as rolling a ball and walking on a board. I give my permission for my child to take part.
>
> _____
> (Sign here)

Revision of Observation Instrument

Because "arm chair" research and limited observation were the sources of the behaviors identified for the six psychomotor problem-solving tasks, the observation instrument was slated for revision after the first set of data were obtained. Revision for each task followed the same sequence: tabulation, summarization, and analysis of data; assessment of each observation form for revision; and coding for computer analysis. Two further steps were taken with four of the tasks. Tasks I and II were subjected to a test for validity of the observations. Tests for sequence effect were made between tasks with similar movements: Tasks I and II, and Tasks III and IV.

Task Behavior Revisions

Although the original observation form had undergone a series of developmental revisions, observer complaints and coding difficulties provided clues for needed changes. A number of unfortunate delays occurred at the point where the 1972 data should have been put into the computer and the analysis for revisions made. Consequently, it was necessary to hand tabulate all behaviors attributed to each of the 172 children for each task. Task behaviors were then summarized by age (half year) and by success and non-success, and analysis made for patterns of behavior. Graduate students compiled all summaries and set up many of the analyses. The 1973 investigator, who based her Master's thesis on the continuation of the study, assisted in revising the original instrument. Additional changes to improve format and to expedite coding were made after use in the 1973 study. The final revision appears in Appendix C.

Revision decisions followed these main rules: (1) maintain behaviors that differentiate age groups as well as indicate success, (2) combine

behaviors into fewer categories, and (3) clarify or add descriptions of behaviors. The greatest change was simplification by consolidation.

Revisions for each task are briefly described:

Task I: Bigness of Body
- Arm movements reduced from 6 to 3.
- Leg movements increased by one category because stretching lengthwise was noted at age 4½.
- Chest (arching) movement added as a separate behavioral category. This had been hypothesized but categorized under miscellaneous.

Task II: Smallness of Body
- Arm and leg movements consolidated.
- New behavior "sits up" added to those for the Upright Position.
- Several behaviors clarified by description. For example, leg movement "folded" was described as "feet brought toward buttocks". The folded leg movement was observed at age 3 with increasing frequency at 5 and 5½.
- The decision made to delete the "chest arched" category and consider such behavior an "error" behavior.

Task III: Serpentine Walk
- Combined arm behaviors (reduced from 10 to 4). The children move so rapidly on this task that only gross movements can be observed. These categories were kept parallel with those for Task V.
- Defined 6 observable "walk patterns" for completing the task. For instance, at ages 4, 4½, and 5, children turned or stepped off the next to the last block.
- The decision was made not to record body stances: hand in/at mouth, hand in pocket, arms folded behind back or over chest.

Task IV: Stepping Stone Walk
- Restructured movement categories for ease in observation.
- Defined "swivel", "stoop", and "squat".
- Deleted hypothesized "encouragement needed to do task" category.
- Established clearer descriptions of observable task solutions.

Task V: Balance Board Walk
- Upper body movements consolidated and kept parallel with Task III.
- Measurement of length of walk deleted as few children walked less than the length of the board.
- Provided clearer descriptions of foot movements.
- Established 5 patterns for amount of heel-to-toe placement.

Task VI: Ball Roll
- Simplified recording of hand movements.
- Added body movements such as "stand", "walks up board".
- Reorganized format for recording highest position of ball during each roll. This suggestion came from a research assistant and greatly facilitated coding the data.

As noted earlier, difficulties arose in getting the data ready for the computer. By the time the bugs in coding were out and a program had been decided upon, the 1973 data had been collected on the revised observation form which added complications. It was important to the research to combine all data. In order to handle this situation, a summary sheet was developed for transposing the observations made in 1972 into the revised categories in a form easily transferred to computer cards. This form proved handy to use to consolidate the information for each child from the three sources it was on and to test some hypothesizing about maturity patterns of behavior for some of the tasks.

Validity of Body Image Observations

One of the procedural questions asked during the development of testing procedure was whether it was possible to visually observe when a child moves sufficiently to change body configuration to "bigger" or to "smaller" without using a tracing or some other more objective measure. To determine the validity of such visual observation, (1) a specific sequence of measurements was made for a portion of the children tested and (2) a panel of judges was asked to evaluate the measurements taken; and (3) those measurements compared with those of the observers.

Every fifth child was asked to lie down on a piece of paper and tracings made in specific order:

1. Body image big and body image small requested in random order. Tracings in two colors of felt pen ink were made on the same sheet of Kraft paper. All tracings were made quickly in order to capture position and at sufficient distance not to stain clothing with the marking pen.
2. Standard body representations, normal and small, were made on a

second piece of Kraft paper, again in two colors (red was consistently used for all tracings of "small"). For these measurements each child was asked to take a face-up position on the paper with heels touching and arms extended at right angles to the body (normal representation) and then asked to sit up and put his arms around his legs (small representation). It was assumed that these positions would provide an observable maximum dimension called "bigness of body" and an observable minimum dimension called "smallness of body."

Seven faculty and graduate students not involved in testing the children were asked to make visual judgments of the traced images comparing the "standard" with the interpretation "large" and "small" of the 25 children aged 2.0 years to 5½ years for whom tracings were obtained. Standard directions in form of a check list were provided each judge who independently evaluated paired tracings for each child after a practice session to establish reliability of evaluations. The judges were directed to look for (1) no apparent difference in body configuration or (2) specific changes in body configuration between the "standard" and the "test" tracings. Changes were defined as increase or decrease in length or breadth of image; specific areas for identifiable change included legs, arms, feet, and/or shoulders and head. Judges were cautioned not to confuse change in location on the paper with change in body conformation.

Judges ratings were summarized and compared with the observations made during testing. Judges identified 11 of the 13 instances of observed movement. All movements toward the smaller body configuration were identified from the tracings. However, the observed movement "chest arched, legs slightly moved" seen during testing as an unexpected response to the

"bigness of body" configuration was not identified nor was the behavior of inching the body toward the top or toward the lower edge of the paper. Rather conflicting results on the identification of "no position change after command" tracings occurred--the agreement level ranged from 50% to 100% among judges on the 16 sets where the observers had recorded no position change.

The conclusion was drawn that the observers were more accurately seeing position change than could be recorded on a tracing. Further, it was concluded that the observer was better able to determine whether a child had made a move of sufficient quality to be considered a position change in response to a given verbal request. The use of the tracings was discontinued.

The following conclusion was reached through comparison of the analyses of the hand tabulations and the responses of the judges, and through discussion with those consultants who were experts on movement: If a movement made by a child expresses the idea "bigger" or "smaller" and he does not maneuver his body out of the site at which the task command was given, the observed movement will be added to the instrument. Any movement of maneuver will be deleted. This decision allowed movements of stretching and arching to be added, and those of "inching" away from the site of command to be deleted.

Sequence Effect Between Tasks

Study consultants believed there might be a sequence effect (transfer of learning) between tasks they judged as similar in movement. Consequently, provision was made to alternate the sequence in which the tasks were presented to the children in order to test the proposition. Chi square analyses were made for (1) difficulty between tasks and (2) sequence effect.

When the data for all subjects on Task I and Task II were analyzed for difficulty, the obtained chi square values for the sequence effect within the same group was significent. Thus, it was concluded that the tasks were of similar difficulty and that no practice or transfer effect obtained. Consequently, directions for alternating the sequence in administering these tasks were abandoned.

When the data for Task III and Task IV were analyzed for difficulty, the obtained chi square value was significant at the .01 level of probability. Task IV was more difficult for the tested children than was Task III. Two different approaches were taken to test for sequence effect. First, comparison was made of the percentages successful for each sequence for each task which gave almost identical results and supported the idea of no sequence effect. Then chi square tests were made within the tasks letting the groups vary. The resulting values were not significant. There was no evidence found of a sequence effect between Tasks III and IV. Consequently, the two tasks were retained in the original ordering.

Data Analysis

Data were coded, placed on cards, and programmed through the computer at the University of North Carolina at Chapel Hill using the 2/01/72 version of the Statistical Package for the Social Sciences.

RESULTS AND DISCUSSION

The purpose of this study was to explore psychomotor problem-solving behavior of preschool children. The results are presented as descriptions and sequential patterns for observed behaviors on six selected tasks. Discussion examines the relationships between those behaviors and Piaget's concept of development. The establishment of tentative scales is explored.

Subjects

All children in this study were arbitrarily classified into age group by birthdate using mid-April and mid-October as division points. For example, any child born between April 16, 1968 and October 15, 1968 was declared in the 3½ year group; any child born between October 16, 1968 and April 15, 1969 in the 4-year-old group.

The socioeconomic factor was determined by the occupation of the father. A standard census listing of occupational groups was used as the basis for categories. Three categories were added: "unemployed," "mother only in family," and "other." In order not to exceed 9 categories, some census groups were combined and the following two socioeconomic levels obtained:

Upper socioeconomic level

1 Professional, technical and kindred
2 Managers, officials and proprietors
3 Clerical and sales workers
4 Craftsmen, foremen and kindred workers

Lower socioeconomic level

5 Operatives and kindred workers
6 Unskilled, service and domestic workers, and laborers
7 Unemployed
8 Mother only in family (i.e., "separated from father")
9 Other (student; undesignated self employment)

Two samples of subjects are included in this study. In selecting the 1972 sample, a concerted attempt was made for balance by age, sex, ethnic background, and socioeconomic level. (See Table 1.) Composition by age ranged from 20% (3 years) to slightly more than 30% (5 years) and there was almost equal division for sex, for ethnic background, and for socioeconomic level. The sample consisted of all children at the only preschool facility of one college, all children at one preschool facility of one university, all children at one private child care facility, and children selected to achieve balance by age and by sex from public child care facilities. Adequate quota sampling in the latter instance could not be achieved. There were no representatives of black upper socioeconomic children age 2, and no black lower socioeconomic males age 3.

In 1973 a convenience sample of all children from all preschool facilities at two universities was the basis for a Master's thesis. It was hoped that these subjects would complement those of the earlier sample; however, that was not the case. (See Table 2.) Unequal proportions existed in the sample: more children of ages 3 and 4 (both 31.6% of the total), more males, more white children, and more children from the upper socioeconomics level.

The combined group (see Table 3) of 270 subjects contained almost equal numbers of children age 4 and 5, and decreasing numbers age 3 and 2. There were approximately 12% more males than females, approximately 12% more children from the upper socioeconomic level, and slightly more than 25% more white than black children.

Gaps in the combined sample exist despite effort to fill them. For instance, there were no 2- or 2½-year-old upper socioeconomic black children tested nor were there any 3-year-old upper black males, 4-year-old upper

TABLE 1

SUBJECTS TESTED IN 1972 BY AGE, SEX, ETHNIC AND SOCIOECONOMIC BACKGROUNDS

Age	No.	% of Total	Sex		Ethnic		Socio	
			M	F	W	B	U	L
Age 2 Total	39	22.7	18	21	26	13	22	17
2	22		11	11	15	7	8	14
2½	17		7	10	11	6	14	3
Age 3 Total	35	20.3	18	17	17	18	22	13
3	17		7	10	11	6	13	4
3½	18		11	7	6	12	9	9
Age 4 Total	44	25.6	23	21	25	19	24	20
4	20		13	7	17	3	14	6
4½	24		10	14	8	16	10	14
Age 5 Total	54	31.4	29	25	25	29	28	26
5	25		13	12	13	12	15	10
5½	29		16	13	12	17	13	16
Grand Total	172	100.0	91	81	94	78	88	84
% of Total			(52.9)	(47.1)	(54.7)	(45.3)	(51.2)	(48.8)

TABLE 2

SUBJECTS TESTED IN 1973 BY AGE, SEX, ETHNIC AND SOCIOECONOMIC BACKGROUNDS

Age	No.	% of Total	Sex		Ethnic		Socio	
			M	F	W	B	U	L
Age 2 Total	13	13.3	9	4	13	0	6	7
2	5		3	2	5	0	1	4
2½	8		6	2	8	0	5	3
Age 3 Total	31	31.6	20	11	16	5	19	12
3	10		7	3	20	0	5	5
3½	21		13	3	16	5	14	7
Age 4 Total	31	31.6	14	17	24	7	23	8
4	16		8	8	11	5	13	3
4½	15		6	9	13	2	10	5
Age 5 Total	23	23.5	17	6	15	8	12	11
5	15		12	3	9	6	9	6
5½	8		5	3	6	2	3	5
Grand Total	98	100.0	60	38	78	20	62	36
% of Total			(61.2)	(38.8)	(79.6)	(20.4)	(63.3)	(36.7)

TABLE 3

ALL SUBJECTS BY AGE, SEX, ETHNIC AND SOCIOECONOMIC BACKGROUNDS

Age	No.	% of Total	Sex		Ethnic		Socio	
			M	F	W	B	U	L
Age 2 Total	52	19.3	30	22	40	12	20	32
2	27		14	13	20	7	9	18
2½	25		16	9	20	5	11	14
Age 3 Total	66	24.4	38	28	43	23	41	25
3	27		14	13	21	6	18	9
3½	39		24	15	22	17	23	16
Age 4 Total	75	27.8	37	38	49	26	47	28
4	36		21	15	28	8	27	9
4½	39		16	23	21	18	20	19
Age 5 Total	77	28.5	46	31	40	37	42	35
5	40		25	15	22	18	24	16
5½	37		21	16	18	19	18	19
Grand Total	270	100.0	151	119	172	98	150	120
% of Total			(55.9)	(44.1)	(63.7)	(36.3)	(55.6)	(44.4)

black males or lower white females. Three or fewer children were tested in several categories.

Task Performance

The analysis of task performance is approached in two ways: (1) group performances on all tasks and (2) specific solutions for each separate task.

Group Performance

Table 4 presents the results of testing 270 children on each of six psychomotor problem-solving tasks in terms of the relation to the total of refusal to participate, success, and nonsuccess. These findings are amplified by selected specifics within each of the following sections.

Refusal. There was an almost steady decrease with increasing age in the percentage of children refusing to participate. The younger children refused to perform all tasks more often. Approximately one-quarter to one-half of all 2-year-olds refused each task; but only one task was refused by as many as 9% of the 5-year-olds. Similarities as well as differences were found for refusal patterns between the two groups tested: the pattern for 3-year-olds varied no more than 4 percentage points for any task and there were no refusals by 5-year-olds in the 1973 group. On two tasks there were plateau periods for refusals: Serpentine Walk at ages 3.0 and 3.5 (12%) and ages 4.0, 4.5, and 5.0 (4%); and the Stepping Stone Walk at ages 3.0, 3.5, and 4.0 (13%).

The refusals of the 2-year-olds appear logical: they may not have understood the directions or they may not have wanted to do what a stranger asked them to do. The examiners for the 1972 study were not familiar to most of the children which may account for their lack of response. When the examiner was known there was little or no refusal.

TABLE 4

PERFORMANCE ON PSYCHOMOTOR PROBLEM SOLVING TASKS
BY 270 PRESCHOOL CHILDREN AGE 2 THROUGH 5

Performance	Age							
	2 Yrs.		3 Yrs.		4 Yrs.		5 Yrs.	
	No.	%	No.	%	No.	%	No.	%
Task I: Body Image Big								
Successful	1	1.9	7	10.6	15	20.0	19	24.7
Not Successful	22	42.3	48	72.7	59	78.7	54	70.1
Refusal	29	55.8	11	16.7	1	1.3	4	5.2
Task II: Body Image Small								
Successful	1	1.9	2	3.0	13	17.3	17	22.1
Not Successful	22	42.3	54	81.8	61	81.3	53	68.8
Refusal	29	55.8	10	15.2	1	1.3	7	9.1
Task III: Serpentine Walk								
Successful	1	1.9	17	25.8	52	69.3	65	84.4
Not Successful	35	67.3	43	65.2	21	28.0	11	14.3
Refusal	16	30.8	6	9.1	2	2.7	1	1.3
Task IV: Stepping Stone Walk								
Successful	0	0.0	1	1.5	5	6.7	16	20.8
Not Successful	31	59.6	53	80.3	60	80.0	59	76.6
Refusal	21	40.4	12	18.2	10	13.3	2	2.6
Task V: Balance Board								
Successful	0	0.0	0	0.0	6	8.0	14	18.2
Not Successful	33	63.5	59	89.4	65	86.7	60	77.9
Refusal	19	36.5	7	10.6	4	5.3	3	3.9
Task VI-S: Ball Roll (Short)								
Successful	5	9.6	10	15.2	15	20.0	19	25.0
Not Successful	35	67.3	51	77.3	57	76.0	55	72.4
Refusal	12	23.1	5	7.6	3	4.0	2	2.6
Task VI-L: Ball Roll (Long)								
Successful	0	0.0	3	4.5	4	5.3	6	7.9
Not Successful	40	76.9	58	87.9	68	90.7	68	89.5
Refusal	12	23.1	5	7.6	3	4.0	2	2.6

Refusals were made more often by the white upper socioeconomic children. Except for the Ball Roll tasks, more males refused to perform the tasks.

Success. In Table 4 success on each task seen as positively related to increasing age. At age 5 the range for success was from 7.9% (Task VI-L) to 84.4% (Task III).

Table 5 presents a second analysis of success--that of chi square values for each task by both year and half year. There it is seen that success is highly related to age--the older the child, the more likelihood of success. Chi square values were lowest for the Ball Rolls (Task VI-S and VI-L) and highest for the Serpentine Walk (Task III).

TABLE 5

SUMMARY OF CHI SQUARE VALUES OF THE RELATIONSHIP OF AGE TO TASK SUCCESS

Task	Chi Square	
	By Year (6df)	By Half Year (14df)
I	83.3***	103.3***
II	83.5***	101.8***
III	125.3***	130.5***
IV	52.5***	57.0***
V	56.4***	62.4***
VI-S	23.6***	29.2**
VI-L	23.4***	28.8*

***p<.001, **p<.01, *p<.05

A different picture emerges when chi square analyses were made for the relation between task success and sex, between task success and socioeconomic background, and task success and ethnic background. No relationship was found

associated with the factor of sex. Only success on Task III (Serpentine Walk) was found to be related to socioeconomic level ($p < .01$)--the greater proportion of successes were made by those classified as from the upper socioeconomic level. Ethnic group membership was found related to task success at varying levels of probability: Tasks I (Image Big), II (Image Small), and IV (Stepping Stones) were at $p < .001$; Task III and Task VI-L at $p = .01$; and Task V (Balance Board) and Task VI-S at $p = .05$. The Long Ball Roll was the only task showing difference in the direction of the black children.

When task success was analyzed from the standpoint of differences between the younger (2 and 3 years) and the older (4 and 5 years) children, it was found that the younger children did less well. Only 16% of total successful performances could be attributed to the younger group. Although the number of successes was small, only on Task V (Balance Board Walk) was no younger child successful. Success for the younger children ranged from 9% to 30% on the other six tasks. Males, whites, and upper socioeconomic children were more successful within each age group; however, the ratio for each grouping moved closer together with increasing age:

	Younger (2-3) (percent)	Older (4-5) (percent)
Male	67.3	63.0
Female	32.7	37.0
White	67.3	59.2
Black	32.7	40.8
Upper Socio	65.3	59.6
Lower Socio	34.7	40.4

Task successes were combined across age and analyzed by sex, ethnic group, and socioeconomic factor. The 314 successes were analyzed first as a whole and then by separating out the two tasks performed from only verbal instruction (Body Image tasks) from those performed from verbal instruction and demonstration. When all tasks were combined, males (60.5%), whites 63.7%), and the upper socioeconomic group (60.5%) were found to be more successful. Little difference, except for sex, was found when comparisons were made by instructional mode:

	Verbal (percent)	Demonstration (percent)
Male	56.0	61.9
Female	44.0	38.1
White	65.3	63.2
Black	34.7	36.8
Upper Socio	68.0	58.2
Lower	32.0	41.8

The further analysis of task successes appearing in Table 6 shows that black males outperformed black females and white females outperformed white males. The greatest difference was that between upper and lower socioeconomic females on the "only verbal instruction" tasks. The black lower socioeconomic male outperformed all other black groups except on the "only verbal instruction" tasks where the black upper sodioeconomic female surpassed him. Females were less consistent in performance between the two types of the upper socio-economic groups doing better on the "only verbal instruction tasks." However, the female white lower socioeconomic group did less well on the spoken instruction tasks.

A pattern indicating a fruitful avenue of study appears when another type of analysis is made. Table 7 shows the percentage of success for ethnic

groups by sex and socioeconomic factor. When a count is made of the larger percentage in each pairing (.8 was considered the minimum for larger), the data show that out of 28 possible instances the black children were more successful 15 times, the white children 11 times, and tied 2 times. The black upper socioeconomic children (12 instances out of 14) and the white lower socioeconomic children (10 out of 14 instances) had greater percentage of task success than did the other two groups of children.

TABLE 6

PERCENTAGE OF 314 TASK SUCCESSES BY SEX, SOCIO-ECONOMIC FACTOR, AND ETHNIC BACKGROUND OF PRESCHOOL CHILDREN

Group	All Tasks	Instructional Mode	
		Verbal	Demonstration
Male (n=190)			
White	60.0	61.9	59.5
Black	40.0	38.1	40.5
Upper Socio	55.3	57.1	54.7
Lower Socio	44.7	42.9	45.3
Female (n=124)			
White	69.3	69.7	69.2
Black	30.7	30.3	30.8
Upper Socio	68.6	81.8	63.7
Lower Socio	31.4	18.2	36.3
By Rank Order on All Tasks By Sex			
Male (n = 190)			
White Upper Socio	41.0	42.9	40.5
Black Lower Socio	25.8	23.8	26.4
White Lower Socio	19.0	19.0	18.9
Black Upper Socio	14.2	14.3	14.2
Female (n = 124)			
White Upper Socio	44.8	51.5	45.0
White Lower Socio	22.6	18.2	24.2
Black Upper Socio	10.7	30.3	18.7
Black Lower Socio	8.9	0.0	12.1

TABLE 7

PERCENTAGE OF GROUP TASK SUCCESS BY SEX, SOCIOECONOMIC AND ETHNIC GROUP

Group	Task						
	I	II	III	IV	V	VI-S[a]	VL-L[a]
Male							
Upper Socio							
White (n=63)	14.3	14.3	57.1	7.9	9.5	17.5	3.2
Black (n=17)	16.7	23.5	88.2	94.1	11.8	17.6	5.9
Lower Socio							
White (n=30)	11.8	10.0	46.7	10.0	6.7	26.7	3.3
Black (n=41)	3.7	2.4	46.3	4.9	0.0	30.0	15.0
Female							
Upper Socio							
White (n=52)	21.2	11.5	46.2	9.6	7.7	13.5	1.9
Black (n=17)	22.0	27.8	55.6	0.0	16.7	16.7	5.6
Lower							
White (n=27)	27.8	18.5	40.7	18.5	11.1	11.1	0.0
Black (n=22)	0.0	0.0	27.3	9.1	0.0	9.1	4.5

[a]Missing data reduces n by 1

Task I: Body Image Big

The criterion for Task I was that the child change his body configuration sufficiently after the command to change position to be judged as conveying an image of big. From preliminary observation and hypothesizing, the following specific criteria were used in scoring performance as successful:

Arms would be extended full (horizontal to vertical positioning)
Legs would be spread as wide as possible or stretched lengthwise
Chest would be arched

Ten possible combinations of variations of these movements were established and two predetermined as optimum: (1) arms widespread and legs widespread or stretched lengthwise or (2) chest arched. Upon this basis, the proportion of successes increased as the age of the children increased--1.9% were successful at age 2 and 24.7 were successful at age 5. No change in position was made by 96 children and 45 refused the task.

When specific movements made by 129 children were analyzed it was found that the full stretch (horizontal or vertical) movements comprised 80% of all arm movements. Slightly more children moved only their legs than moved only their arms--almost twice as many females than males moved arms only. Of those who moved their legs, half stretched them lengthwise or spread them widely apart. The expected full stretch movements of arms and legs did not appear until age 4.0 and a total of only 8 children were successful on this basis.

The interesting finding was in the analysis of the four preconceived combinations relative to arching the chest:

Age	Chest Only	Chest, Arms and Legs	Chest, Legs	Chest, Arms	Total
2½	1				1
3	1				1
3½	6	1			7
4	10	1			11
4½	2	6	1		9
5	8	3	3		14
5½	6	6	5	1	18
Total	34	17	9	1	61

Sixty-one of the children (22.6% of the total) made movement with the chest. It appears that at the age of 3½ many children begin to use the "thorwing out the chest" movement to show how they make their body bigger. This movement peaks at age 4.0 and the body configuration begins to be increased by movement of arms or legs or both. Over one-quarter of the 4-year olds (26.7%) and over two-fifths of the 5-year olds (41.6%) used the chest movement to show body bigness. A few more boys than girls arched their chest. Otherwise, there was little sex difference in movement on this task. Further, there was no major ethnic or socioeconomic differences--arching of the chest was the movement made most often by all groups. Blacks and the upper socioeconomic children made the arching of the chest movement somewhat more frequently.

Task II: Body Image Small

The criterion for Task II was that the child change his body configuration sufficiently after the command to be judged as conveying an image of small. From preliminary observation and speculation, the following specific criteria were used in scoring performance as successful:

Body would be curled--position on back, on side, or seated
Arms would be tight to body or folded under head
Legs would be touching or brought toward buttocks

Eight possible combinations of variations of these movements were established

and three predetermined as optimum: (1) body would be curled tight, (2) legs would be folded toward buttocks and arms would be tight to body, and (3) legs would be touching and arms would be tight to body or folded under head. Upon this basis the proportion of successes increased as the age of the children increased--1.9% at age 2 to 22.1% age 5. No change in position was made by 98 children and 45 refused the task.

Arms placed near or tight to the body (90% of all arm movements) and legs folded to buttocks (62% of all leg movements) were the most frequent movements made by 127 children who moved to indicate body smallness. Slightly more children moved legs only than moved arms only--there was little difference between sexes on these movements, but both movements were made more by whites and by lower socioeconomic children (twice as often in each case). The arms only movement appears to belong to the 3- and 4-year-olds; the legs only movement to the 4- and 5-year-olds. Four children aged 4 or 4½ folded their arms under their heads.

Of the positions hypothesized, the side curl was exhibited by 7 children (4 curling tightly, all 4- and 5-year-olds; 3 curling slightly at ages 2 and 4); the sitting position was exhibited by 8 children (2 older children sitting with arms around legs; 1-3 children in each age group rising to a seated position); only 2 older children took the curled position on the back. Frequencies for the predetermined success criteria were:

Age	Tight curl	Legs folded, arms tight	Arms under head or close, legs close	Total
2½			1	1
3			2	2
3½		1	1	2
4	1		3	4
4½	1	4	6	11
5	5	3	6	14
5½	1	3	5	9
Total	8	11	24	43

Movements in the third category were made twice as often by upper socio-economic children. However, there was little sex or ethnic difference. Slightly over 14% of the 5-year-olds made the movements. It could be that a separate category including the "arms under the head" movement would identify a behavior of older children.

Due to an error in coding, 10 instances of success on Task II were not included in any data analyses relative to the success factor. These instances would make the following identified differences:

Factor	Increase for Success		
Age	3 years	2	3.0%
	4 years	2	2.7%
	5 years	6	7.8%
Sex	5 male, 5 female		
Ethnic	8 white, 2 black		
Socioeconomic	9 upper, 1 lower		

Task III: Serpentine Walk

The path for Task III consisted of 12 wooden blocks placed in a reverse S approximately eleven feet in length. The criterion for this task was that the child step on each block consecutively from starting point to end of walk, must turn on or touch foot to the last block, and return to the starting block stepping consequtively on each block. Specific scoring criteria for success were:

23/24 blocks would be stepped on consecutively
The turn at the mid-point of the task would be made without stepping off the blocks

Six walk "patterns" were established and two predetermined as optimum: (1) walks each block consecutively to #12, turns on #12, and returns on

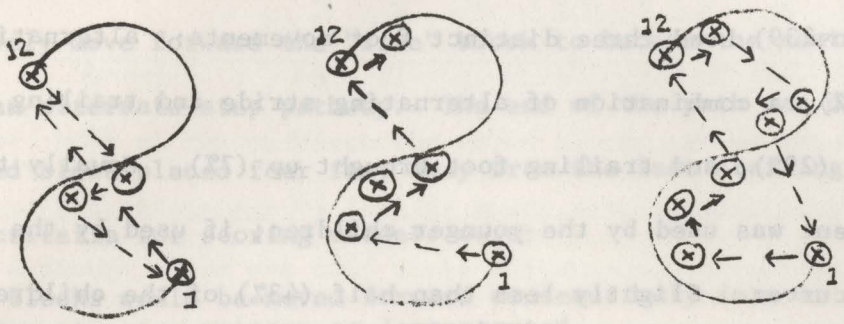
path to #1 and (2) walks each block consecutively to #11, touches 12, turns and returns on path to #1. A total of 137 children were successful by these criteria--90 for the first proposed solution and 47 for the second. Only 25 children refused to participate. The percentage of success rose from 1.9 at age 2 to 84.4 at age 5--the children were more successful on this task than on any other.

The two optimum "patterns" were decided upon before any data were collected. It was hypothesized at that time that the second pattern with a swivel turn, which calls for agility, would be the performance of older children. The data show that this was true. The summary that follows shows the two optimum as well as the four patterns derived from the 1972 study:

	Pattern					
Age	1	2	3	4	5	6
2			1		3	4
2½	1		1	3	1	2
3	4	2	8	3	1	1
3½	8	4	9	1	1	1
4	13	10	2	3		
4½	24	6	4	1		1
5	22	10	1	1	2	
5½	18	15	1	2		
Total	90	47	27	14	8	9

Pattern 4, walking blocks 1-12 consecutively and stopping, had a rather consistent number of users, though a small number at each age. This was a pattern used more by white (3½ times) than black children, more by those from upper socioeconomic backgrounds, and slightly more by males. Patterns 3, 5, and 6 are illustrated:

Pattern 3 Pattern 5 Pattern 6



Pattern 3 shows the child going directly to the block with the yellow circle on it (#12) and returning with one jog to the starting block. This could be a function of the directions--or a function of the memory or understanding of the 3-year-old. At least, the performance peaks at that age and then declines. Twice as many females and about seven times as many lower socioeconomic children used pattern 3. Pattern 6 appears to be an extension of pattern 5: the child makes his way to block 12 and its neighbor--then takes a short route back to the starting block. These patterns are those most typical of the 2-year-old lower socioeconomic child. A total of 41 children attempted the walk but completed it in such an erratic manner that no patterns emerged. A large proportion of these children were white and, as would be expected, almost three-quarters were of the younger group (age 2 and 3).

Although there was no ethnic difference in success, a greater percentage of male and upper socioeconomic children were successful. In each case, the ratio was approximately 6½:5.

The children completed Task III so rapidly that only general movement patterns were identified by naturalistic observation. Analysis by frequency provides a general picture of selected body movements. The children (n=239) used three distinct foot movements: alternating stride (61%), a combination of alternating stride and trailing foot brought up (29%), and trailing foot brought up (7%). Usually the trailing foot movement was used by the younger children; if used by the older children, it was on curves. Slightly less than half (43%) of the children were uncertain in the walk--slipped, stumbled, or stepped off the blocks. Three-quarters of the children used their arms for balance: 40% raised them in a position other than diagonal; an almost identical number used one arm or used both arms in a diagonal position (18% and 17% respectively); and 26% kept their arms close to the body (including on the hips and in the pockets).

Cross tabulation of foot and arm movements showed the following combinations for the total group of 241 children:

21% used the alternate stride and raised arms to a position other than diagonal for balance
17% used the alternate stride and held hands close to the body
14% used the combination foot movement and raised arms to a position other than diagonal
12% used alternate stride and both arms diagonally
10% used the alternate stride and one arm diagonnally for balance

Further analysis needs to be made of these behaviors--for age and for sex differences.

Task IV: Building a Stepping-Stone Walk

At the start of Task IV, three stepping-stone blocks were positioned in an alternate-stride pattern (left, right, left). The criterion for the task was that the child, while keeping one foot on each of two blocks, consecutively move forward the "free" block to become the next stepping stone in an alternate-step pathway. The end of the path was designated by a marked block placed four feet away from the last starting block. Specific criteria for scoring success were:

Five blocks would be moved forward consecutively into an alternate-step pattern as demonstrated
One foot would be placed on each of two blocks as the "free" block was moved
The step to each newly placed block would be made with the alternate foot

Observation provided sufficient information to establish several ways in which the task might be solved -- one was predetermined as optimum: The child would build a walk consisting of 5 stepping-stones with each stone spaced and staggered, and with the first "free" stone staggered to the right. Although there were only 35 children successful at this task, there was a steady increase from 1.5% successful at age 3 to 20.8% at age 5. Task IV was refused by 45 children--was refused by more 3- and 4-year-olds than any other task.

Three general types of solution to Task IV were found: (1) Walking the positioned blocks with no movement of blocks, (2) movement of at least one block with placement of the first block to the left (repeat of the pattern), and (3) movement of at least one block into a continuation of the staggered pattern. The distribution of these patterns by age for 169 children was:

Solutions to Task IV

Age	Walked pattern blocks	Walked pattern blocks and goal	Tight, 1st block to left	Spaced, 1st block to left	Staggered, spaced, 1st block to right
2	3	2			
2½	7	4			
3	11	2	1	2	2
3½	10	12	1	1	3
4	6	4	4	2	5
4½	6	5	2	7	10
5	3	4	2	3	17
5½	5	1		8	14
Total	51	34	10	23	51

Half of the children received only the idea of walking on the blocks--mainly as 3-year-olds. More 3-year-olds walked only the pattern blocks than walked the pattern blocks and the goal block. The movement of the "free" block begins at age 3.0 and increases steadily with increasing age. As hypothesized, the staggered, spaced placement of blocks is the solution made by the older children although about one-quarter of them did not remember the positioning for the "free" block as 5-year-olds. Only a few children who moved any blocks, moved them into an undiscernable pattern. The chi square values of the relationship of age to task solution were the .01 level (121.7, 56 df) by half year and greater than .001 (79.0, 24 df) by the year. A greater percentage of males solved Task IV by walking pattern blocks (58.8%) or by walking the pattern and goal blocks (64.7%); slightly more females (54.9%) performed the staggered, spaced solution.

The second element of task success was the movement of 5 blocks into the correct positions. Analysis shows that the children began to successfully move blocks at age 3:

Age	Blocks Successfully Moved					
	1	2	3	4	5	Total
3	1			1		2
3½		1	1		1	3
4		1	3		1	5
4½	2	2	2		4	10
5	2	3	5	1	7	18
5½	3	4	1	3	9	20
Total	8	11	12	5	22	58

Approximately half of the children who moved blocks, moved them successfully. A greater percentage of females moved blocks successfully than did males, although there was only minor differences in performance with 3 or 4 blocks. In terms of successful performance (5 blocks), there was a slight difference in favor of the females and lower socioeconomic group, and the white children were 4 times as successful as the black children.

Analysis of body movements and foot movements were made by frequency count. In general, combined movements were more often used in performing Task IV than were single movements. For example:

Movement(s)	Number
Swivel, stoop, squat	31
Swivel, stoop	25
Stoop	25
Stoop, squat	23
Squat	14
Alternate foot on blocks	56
Alternate, both feet on block	42
Alternate, both on block	19
Both feet on floor	13
2-hand pickup	62
1-hand, 2-hand pickup	25
1-hand pickup	14
Blocks taken around side	92
Blocks pushed along floor	39
Blocks moved between legs	19
Pushed along floor, between legs	19

A very few children (17) balanced themselves by placing their hands on the floor. Crosstabulations were made for body movements and foot

movements and by the factors of age, sex, ethnic background, and socio-economic level for hand movements and block movements.

Three predominant patterns of body/foot movement were found:

2 body movements/2 foot movements	3, 3½, 4, 4½
stoops/2 foot movements	4, 5
2-3 body movements/alternate foot	4½, 5½

The older children (4 and 5 years) used the alternate foot movement only slightly more than combining two foot movements to solve the task. Combined body movements (2 movements more often used than 3) was also an older performance. The males most often used two movements of both body and feet while the females most often used the alternate foot movement and two body movements. The analyses of use of hand and movement of blocks revealed that the 2-hand pickup of block/carrying the block to the side was the most predominate pattern of performance (4½, 5, 5½ and the older children taken as a single group). However, a sex difference was found: the males used the 2-hand pickup (15.3%) and the side movement of blocks; while the females also used the 2-hand pickup (26.6%) they pushed the blocks along the floor. There was little ethnic or socioeconomic difference.

Task V: Balance Board Walk

The criterion for Task V was that the child walk heel-to-toe for eight feet on a 1½" line centered widthwise of a 2" x 8" board. Only 20 children, all age 4 or 5, were successful at this task. There was an increase from 8.0% to 18.2% success with age. Thirty-three children refused to participate in this task. Analysis was made of the amount of heel-to-toe placement with the following results:

Age	Every step	Missed 1-3 steps	Half	Only 2-3 steps	Total
2½			1		1
3		1	1	7	9
3½		4		9	13
4	1	12	1	9	23
4½	5	8	2	11	26
5	6	11	4	6	27
5½	8	8	1	12	29
Total	20	44	10	54	

In the 1972 portion of the study, the observers reported that when a child took only 2-3 steps heel-to-toe, the steps were almost always either at the beginning of the task, or there would be a start of 1-2 steps heel-to-toe then strides until the last 1-2 steps which again would be heel-to-toe. It can be seen in the frequency table that almost equal numbers of 4- and 5-year-olds either missed 1-3 steps or took only 2-3 steps heel-to-toe.

As almost all of the children walked the full eight feet of the task, analysis was made of how the unsuccessful children accomplished the walk. The results for 143 observations were:

40% Walked along stripe (feet were off stripe)
19% Stepped on the toe of their shoe or slid foot over the toe
18% Placed alternate foot off stripe
11% Placed instep to toe
7% Slid foot down the stripe (no stride)
4% Brought trailing foot up

Walking along the stripe was more a behavior of the younger children (age 2 and 3) while stepping on the toe of the shoe or sliding the foot over the toe was a behavior of the older children. Thirty-seven children used more than one foot movement to complete the task.

Arm movement classifications for Tasks III and V were the same. Frequency analysis showed that 46% (of the 222 observations for Task V) of the children held their hands close to the body while doing the task, 31% raised their arms to a position other than diagonal, 15% moved both arms diagonally for balance, and 7% used one arm diagonally. Comparison between Tasks III and V showed that almost half (45.1%) of the children used the same arm movements on both tasks. The largest groups were those children raising arms in a position other than diagonal (10.3%) and those keeping their hands close to the body (16.2%). The largest group varying arm positions between tasks (11%) raised arms in a position other than diagonal on Task III but kept them close to the sides for Task V.

More data are needed about age and sex performance on both foot and arm movements.

Although an equal number of males and females were successful on this task, the females had a slight edge percentagewise; the white children were two times as successful and the lower socioeconomic group slightly more successful. No sex difference was found on near success (missed 1-3 steps) but slightly more females and upper socioeconomic children achieved this level of performance. At the other end of the success scale, taking only 2-3 steps heel-to-toe, there was one slight difference found--a slightly greater percentage of males solved the task in this manner.

Task VI: Ball Roll

The criterion for Task VI was that the child roll two out of three balls into the second and farther of two inclined targets while seated at the base of the target board. Prior to scoring for the Short Ball Roll, each child was allowed 3 practice rolls. Data for this task are considered in two parts--the Short Ball Roll and the Long Ball Roll (criterion). Originally success for this task was the score for three balls rolled into the hole; however, the fact that no 5-year-old was able to place that many balls in the hole resulted in the scoring revision. This task had the fewest successes of the six--4.5 at age 3 to 7.9% at age 5. It also had the fewest refusing to participate--mainly white, upper socioeconomic females.

On each of the 3 criterion ball rolls 11-13% of the children were successful; on each of the 3 short rolls 25-27% were successful. Performance by age was:

Age	Short Ball Roll Balls in Hole				Long Ball Roll Balls in Hole			
	0	1	2	3	0	1	2	3
2	12	5	3		19	1		
2½	15	3	2		17	3		
3	16	7	2		22	3		
3½	17	11	7	1	24	9	3	
4	20	9	5		22	11	1	
4½	6	22	7	3	25	10	3	
5	15	12	10	1	20	14	4	
5½	13	15	6	2	18	16	2	
Total	114	84	42	7	167	67	13	

As can be seen, the peak for no balls in the hole was at age 4 for the Short Roll and at 4½ for the Long Roll. In general, as the children got older there was a steady increase for each accuracy category. The first children successful on each part of the task was at 3½ years. On the criterion (Long Ball Roll) black children (male 70%, female 67%) were more successful as were the lower socioeconomic males (70%) and upper socioeconomic females (67%). The following groups were the more successful on

the Short Ball Roll: the white male (56%), the white female (67%), the lower socioeconomic male (59%), and the upper socioeconomic female (56%). Black children were superior in putting 1 or 2 balls into the hole and equally as successful as white children in placing 3 in the hole.

A summary of the placement of the ball on the target board shows that over half of the children rolled the ball too hard on each roll for each part of the task:

Placement of Ball	Short Roll			Long Roll		
	1	2	3	1	2	3
Bounces off	4.0%	4.8%	4.4%	11.1%	12.3%	13.9%
Top half, more than 6" above target	30.0	31.3	38.1	34.1	36.9	36.1
Top half, 6" yellow target area	19.0	17.9	12.7	10.3	8.7	13.1
Total	53.9	54.0	55.2	55.5	57.9	63.1
In hole	25.0	27.0	27.0	11.1	13.1	13.1
Bottom half, 6" yellow target area	7.9	9.4	5.1	7.5	5.2	4.4
Bottom half, more than 6" below hole but less than 30"	10.3	8.3	9.1	17.9	17.1	14.7
No higher than 30" from floor	--	--	--	4.8	3.6	2.0

By the third short roll more children were rolling farther past the 6" yellow ring around the hole. On the long rolls, more children rolled the ball off the board or didn't roll it hard enough to reach the target ring (16.7 to 22.7%).

Analyses were made to determine whether the children accommodated to the position of each ball as it rolled in relation to the hole. Of the 80 crosstabulations of the relationship of the last criterion ball rolled to the first and second, using a 5-point scale for strength of roll, only two chi square values reached the .01 level of probability and three the .05 level (an additional seven reached or approached the .10 level).

These were:

Variable	Last Roll	P
Age 4.0	Hard	.01
Age 5 (year)	Correct	.01
Age 2½	Easy	.05
Age 5 (year)	Hard	.05
Older Group (4-5)	Hard	.05
Female	Too hard	.10
Age 5.0	Hard	.10
Age 5½	Correct	.10
Age 4 (year)	Hard	.10
Age 5 (year)	Too hard	.10
Older Group (4-5)	Correct	.10
Male	Correct	Approaching .10

Height/weight Relationship to Performance

An area neglected in research with small children is the relationship of height and weight to psychomotor task success. In this study, chi square analyses were made of performance by age for weight (below and above average) and for height (below and above average). Chi square analyses also were made of the four possible height/weight combinations, hereinafter designated as short/light, short/heavy, tall/light, and tall/heavy.

As seen in Table 8, the variable most significantly related to performance was above average weight (all tasks at .001 level) followed by below average height (5 tasks at .001 level) and below average weight (3 tasks at .001 level and two at .01). Above average height was significant for only the Serpentine Walk. Highly significant relationships to performance were found for two of the combined groups: the tall/heavy children (5 tasks at .001 and one at .01) and the short/light children (3 tasks at .001, one at .01, and one at .05).

TABLE 8

RELATIONSHIP OF TASK PERFORMANCE TO HEIGHT AND WEIGHT

Variable	No.	Level of Significance I	II	III	IV	V	VI-S	VI-L
Height								
Below average	121	.001	.001	.001	.001	.001		
Above average	143			.001				
	264							
Weight								
Below average	114	.001	.001	.001	.01	.01		
Above average	149	.001	.001	.001	.001	.001	.001	.001
	263							
Short/Light	120	.001	.001	.001	.01	.05		
Short/Heavy	23			.05				
Tall/Light	20				.05			
Tall/Heavy	91	.001	..01	.001	.001	.001	.001	.001
	263							

When percentage of success was compared by task, children of above average weight were 1½-3 times as successful on all tasks except Body Image Big where there was a slight difference favoring those of below average weight:

Task	Weight Light	Weight Heavy	Height Short	Height Tall
	(Percent)		(Percent)	
I	16.1	15.7	11.2	21.5
II	6.0	20.9	6.3	19.8
III	36.9	69.6	29.4	76.9
IV	4.0	13.9	4.2	13.2
V	3.4	13.0	2.1	14.0
VI-S	14.8	23.7	18.2	19.2
VI-L	4.0	6.1	2.8	7.5

The comparison between the two height groups showed the tall group exceeded the short group on all tasks. However, there was a 2:1 difference on Body Image Big, a 7:1 difference on the Balance Board Walk, and almost equal success on the Short Ball Roll.

The percentage of success on each task for each of the four combined height/weight groups was contrasted with the following results:

High Percentage Success

Tall/Heavy (Tasks II, IV, V, VI-L; 5 years)
Tall/Light (Tasks I, III; 4 years)
Short/Heavy (Task VI-S; 3 years)

Low Percentage Success

Short/Light (Task II, III, IV, V, VI-L; 4 years except for one age 3)
Tall/Light (Task VI-S, 4 and 5 years)
Short/Heavy (Task I, 2 and 5 years)

An interesting sidelight was the fact that the tall/light children refused to participate in only one task - the Serpentine Walk.

Comparisons by age showed that 5-year-olds of above average height and of above average weight surpassed in successful performances. In general, the lighter and the shorter 4-year-olds outperformed the other groups with the following exceptions: in the below-average weight group, they tied with the 5-year-olds on the Stepping-Stone Walk; in the below average height group they tied with the 3-year-olds on the Long Ball Roll; and the below average height 3-year-olds outperformed everyone on Body Image Big and the Short Ball Roll.

Discussion

The overall purpose of this study was to investigate the sequence(s) in psychomotor development of preschool children by devising problem-solving tasks. By testing children between the ages of 2 and 6, the data were obtained that was needed to (1) determine sequential patterns for gross motor behaviors, (2) determine relationships between findings and Piaget's concept of development, and (3) establish tentative scales of motor behavior for preschool children at one year intervals. A specific question of concern was: If a psychomotor problem-solving task is pre-

sented to the child in the preoperational stage, will he be able to conserve--to maintain the invariance of the configuration of that specific task?

The first question to be raised is that of whether the tasks devised were indeed psychomotor problem-solving tasks. According to the definition created for the study,

> A problem-solving task is one to which a number of solutions can be made--ranging from hesitant and uncertain movements indicating that data are being manipulated (problem solving) to the highly skilled, confident performance. This task will present a "new" situation to children between the age of 2 and 6. Solution of the problem is an expression of accommodation in the Piagetian sense. The problem will be of sufficient difficulty that the average child at age 2.0 will not be successful but the average child of approximate age 5.5 will be successful.

A summary of the success of the problem-solving tasks devised for the study allows consideration of the difficulty of each task:

	Percentage of 270 Children successful by Age			
Task	2	3	4	5
I	1.9	10.6	20.0	24.7
II	1.9	6.0[a]	20.0[a]	29.9[a]
III	1.9	25.8	69.3	84.4
IV	0.0	1.5	6.7	20.8
V	0.0	0.0	8.0	18.2
VI-S	9.6	15.2	20.0	25.0
VI-L (criterion)	0.0	4.5	5.3	7.9

[a] Correction causes difference from Table 4

The tasks presented a wide range of difficulty for the preschool children to whom they were administered. If 10% success is considered minimal, then all tasks were too difficult for the 2-year-olds. In fact, one task was too difficult even for 5-year-olds. If the 75% criterion is used as the "success level" for scaling (Lavatelli, p. 35), then only Task III would meet both criteria. The Short Ball Roll (Task VI), although not criterion for that task, appears to be similar in difficulty to the rest of the tasks. Testing 6- and 7-year-olds would provide a more complete

picture of the preoperational child's response to these psychomotor problem-solving tasks.

Analyses of gross movements as well as movement patterns used in the solution for each of the six tasks, supported the assumption of the problem-solving nature of each task. The children manipulated the data in many ways--identifiable and different patterns were found for the younger (age 2 and 3) and for the older (age 4 and 5) children; differences also were found between the sexes, the ethnic, and the socioeconomic groups.

The data support the assumption of "new" situations being presented to the children. All tasks were such that after age 2, the children were highly interested and no more than 18% refused to participate in any task. The refusal rate for 2-year-olds ranged from 23% (Ball Roll tasks) to 56% (Body Image tasks). The pattern of refusals between age groups was similar but the numbers refusing were smaller for the 1973 sample--the exception was the perfect record for participation set by the 1973 5-year-olds. Some of the 2-year-olds were no doubt still in the sensorimotor stage of development where there is little ability for abstract reasoning (the Body Image tasks were abstract as no examples were given--the child was expected to interpret verbal presentation of concepts). If, as Piaget proposed, the young preoperational child's thought consists of representations (images) as well as language, the classification processes called for by these tasks may be lacking. This would be true of all other situations where the "new" situation was presented to children with insufficient maturity and experience (assimilation) for accommodation (problem-solving) to take place.

Curricula in few preschools would include tasks such as the ones in

the study. This seems to be reflected in the performance of the lower socioeconomic and the black children. According to Piaget, children learn through action, consequently, if their repertoire of actions is sparce, a greater number of situations are new and their solutions to psychomotor tasks will differ from those of the child with the larger repertoire of actions. Some children, of course, make their own experiences--especially the children from the lower socioeconomic urban neighborhoods.

Several aspects of the preoperational child's thought appear in the performances on the psychomotor tasks: (1) the focus on limited aspects of a situation, (2) inability to see connections among several things or events, (3) inability to understand part-whole or ordinal relations, and (4) inability to follow or apply rules after professing they are known. The best examples of these appear in the data for the complicated Building a Stepping-Stone Walk task. The youngest children saw only the blocks and walked on them as they had on the Serpentine Walk--they did not distinguish the difference between the tasks nor did they remember the rules (instructions). By age 5, the children were beginning to form the walk as they had been shown how to do. The solutions used on the Serpentine Walk, especially where the children walked across the path, point up the inability to see both part-whole and ordinal relations. The older children, after practicing walking heel-to-toe for the Balance Board Walk, assured the observers they knew the rules for the task--but often forgot to place their feet heel-to-toe after the first steps.

Aspects of preoperational figurative cognition are seen also. The "copies" of reality produced by the children included the mental imagery called for by verbal instruction only in the Body Image tasks; perception

by which the children reproduced an immediately present object (Stepping Stone task solution where the "pattern" blocks were reproduced rather than the demonstrated different response); and imitation, or the reproduction of actions of those demonstrating, on the remainder of the tasks.

When a new event occurs, the individual modifies his current patterns of behavior to respond to the requirements of the situation--the greater his experience, the more easily he adapts to an increasing number of situations. The child uses the operations of classification to call forth the behaviors needed to solve a given problem. The younger children, who were successful in walking the Serpentine Walk, probably saw the Building the Stepping-Stone Walk as the same, consequently walked but did not move blocks--these children were not yet adept enough to classify the tasks differently. The children were given a model (two repetitions) for all but the Body Image Tasks. For the Balance Board Walk, they were also given practice of walking heel-to-toe on the floor. Piaget says that children learn through activity rather than instruction. Many of the children were so interested in getting on with the task, they probably did not listen to directions.

At about the age of 2 (early preoperational stage), children begin to have the ability to form mental symbols which are the idiosyncratic understanding or intellectual construction of a real object gained through the process of accommodation. The young child performs imitations of mental symbols in abbreviated movements; with increasing age these movements can become so abbreviated as to be almost impossible to detect. In performing the Body Image tasks, many of the older children scored as unsuccessful may have made almost undetectable abbreviated movements which were missed

by observers trained to look for gross movement. Some of the younger 2-year-olds were still in the sensorimotor period--and had no mental image of the concepts "make your body big" and "make your body small." From the data, it appears that the body small concept is attained at an older age than is the body large concept.

The young child interprets words in terms of his own personal system of meaning which are not necessarily the same as those of adults. Children distort language to fit their own mental structure--distort utterances as listeners. Listeners, according to Piaget, do not understand speakers very well--because of the listener's own patterns of thought, he distorts what someone else says. This may be reflected in the performance of the lower socioeconomic and of the black children on the verbal instructions only tasks.

In Piaget's developmental theory, knowledge of reality must be discovered and constructed by the activity of the child. The response to the Ball Roll task shows this aspect fairly well--after three practice rolls on the short board, 45% of the children placed one or more balls into the hole; upon changing to the long board, the number dropped to 29%.

One possible explanation for a behavior found in the Balance Board Walk, that of stepping on the toe of the shoe made by the older children, is that data were collected in the spring and many of the children were wearing sneakers. Because of their growth from the last wearing of sneakers, no doubt the shoes were of a larger size and the children may not have adjusted to them. The use of alternating feet part way on the Balance Board Walk by the 3-year-olds and use of the alternating feet all the way by the 4½-year-olds corresponds to the findings of Bayley. One

of the indoor games from The Travelers Book of Children's Exercises, developed by physical educators in Belgium and in the United States, is that of having a child walk heel to toe on a line marked on the floor without losing his balance (p. 13).

There is the possibility of a tiredness factor in the results of Task VI criterion, the Long Ball Roll. Usually if children are not successful they lose interest; however, in this case they did not. They would have kept on rolling the ball as long as the research assistants would have allowed. The task was used as an interest getter with children who were holding back and acting like they would not participate--and it often got them interested enough to go through some of the tasks.

This study also sought to discover how well the preoperative child would be able to conserve--to maintain the invariance of the configuration of specific psychomotor problem-solving tasks. For each of the four tasks (III, IV, V, VI-S) presenting a configuration to be conserved, the data show that there are a varying number of the older children (age 4-5) who can conserve. The tasks can be ranked by degree of difficulty. The Short Ball Roll has been included in this category rather than the Long Ball Roll which is not a task of conservation but of compensation or accommodation.

SUMMARY

This study was undertaken as an exploratory investigation of selected aspects of psychomotor development of preschool children--specifically to identify the gross behaviors and patterns of behaviors associated with selected psychomotor problem-solving tasks. Piaget's concept of development was the source of the assumptions upon which definitions were based. A psychomotor problem-solving task was defined as one to which a number of solutions of varying degrees of proficiency could be made, each solution being an expression of accommodation in the Piagetian sense.

In addition to the investigation of psychomotor behaviors, an equally important purpose of this study was to institute the major goals of the Home Economics Center for Research at the University of North Carolina at Greensboro by involving in research faculty and students from across subject areas, departments, and institutions. Because of the wide mix of people at each stage of the study and the fact that it was a learning situation for most of those involved, progress was often slow and a few controls for bias were necessarily sacrificed. This specific purpose was successfully fulfilled--cooperation was high between institutions of higher education, between community organizations and the university faculty, and among faculty and students of different subject areas and departments. Undergraduate and graduate students were involved as research assistants in all aspects of the study and were not only interested but extremely capable and helpful.

The study consisted of two parts--the developmental phase (1972) where the tasks were selected, testing methodology developed, and data on 172 children collected; and the refinement phase (1973) where the procedure

was revised and tried out, and data on an additional 98 children were collected. The developmental phase and analysis of the combined data for 270 subjects is reported and analyzed herein. The refinement phase is to be reported in greater detail in a Master's thesis.

The first step in the study was to identify a series of motor tasks which would present a "new" situation to children between the ages of 2 and 6 and could be interpreted in Piagetian terms.

Four types of psychomotor problem-solving situations were judged suitable for discerning both selected gross movements made by individuals and patterns of movements made at different ages. Descriptions, criteria for success, testing equipment, and procedure were devised for these situations:

1. Expressing body image. Task I, Body Image Big, and Task II, Body Image Small. Verbal instructions only.
2. Maintaining balance in forward motion. Task III, Serpentine Walk, and Task V, Balance Board Walk. Demonstrating and verbal instructions.
3. Maintaining balance while moving an object. Task IV, Building a Stepping-Stone Walk. Demonstration and verbal instructions.
4. Controlling an object rolled up an incline. Task VI, Short Ball Roll and Long Ball Roll. Demonstration, verbal instructions, and practice.

The testing equipment, built by a local carpenter, was designed to be transported by women in a standard 4-door sedan. The equipment consisted of a set of 12 wooden blocks each 2" x 6" x 8"; one 8 foot hinged board, cut from 2" x 8" stock, with a 1½" strip of black pressure sensitive tape centered lengthwise; two boards (60" and 72") each framed on sides and

top, each with the same angle of incline, and each with a colored target area and hole centered 12" from the top edge; and two sheets of 60# Kraft paper, one used as a background and the other containing the pattern for block placement for one of the tasks.

In order to have consistent procedures used when testing the children, written constants (standards) were established for how each task was begun, what was demonstrated, and/or how equipment was used. The research committee members most experienced in working with small children developed and refined all instructions for testing. Sets of instructions were typed on 3" x 5" cards for ease in handling and consistency in presentation to subjects. The forms for recording observations grew out of a search of the literature, hypothesizing, and watching a limited number of children in free play and in structured situations. The crucial movements for each task were identified and became bases for observation forms. Each form consisted of three sections of check lists: upper body movements, lower body movements, and descriptions of ways in which progress might be made through the task. Space was provided for written comments. Diagrams were provided for two tasks. Demographic data were recorded on a separate form.

All data were collected by student research assistants who were trained by a different person for each part of the study. Written, detailed instructions were developed and provided for each of the research assistants as well as for agencies and individuals cooperating in the study. In 1972, undergraduate and graduate students were trained to work in teams of two who alternated in administering the test and in accurately observing and recording both the upper and the lower body movements. This group was

trained by the committee member who established the schedule and made all contacts for testing. In 1973, the senior investigator trained a Master's degree thesis candidate to administer all tests and, in addition, trained observers who would work in teams of two. This group was trained at the site where they would collect the data.

A number of delays kept the data from being placed into the computer, consequently revisions of the observation forms were made from hand-tabulated analyses of all behaviors attributed to each of the 172 children on each of the six tasks. Summarizations were made by age (half year) and by success and nonsuccess; from these, analyses were made for patterns of behavior differentiating age groups as well as success, for clarification or additional descriptions of behaviors, and for ways to combine into fewer categories. Following the revision, it was necessary to develop a summary sheet for transposing the 1972 data into the revised categories and into a form easily transferred to computer cards. Only minor revisions were necessary after the 1973 study.

During the developmental stage of the study, the validity of having Body Image observations made without using a tracing or some other objective measure was tested. Tracing of a "standard" body configuration, of the interpretation of "big" and the interpretation of "small" had been made for 20% of the children tested. A panel of judges, after a brief training session, independently evaluated paired tracings for each child. These judgments were then compared with the judgments made by the two observers during testing. The results showed that the observers were more accurately seeing position change and were better able to determine the quality of position change than was possible from assessing a tracing.

Consultants for the study believed there might be a sequence effect (transfer of learning) between tasks judged as similar in movement--Tasks I and II, and Tasks III and IV. Each set of tasks was alternated from child to child during testing. The results were analyzed by chi square for difficulty between tasks and for sequence effect. No practice effect or difference in difficulty obtained between Tasks I and II. Task IV was found to be more difficult than Task III but no support was found for sequence effect.

Subjects were arbitrarily classified into age groups by date of birth and into socioeconomic level by occupation of the father. Although a concerted effort was made to achieve a balance by age, sex, ethnic background, and socioeconomic level, the 1972 sample lacked balance in age groups and the 1973 convenience sample was unequal in all aspects. The samples consisted of children from preschool facilities at three institutions of higher education, from one private child care facility, and from publicly supported child care facilities. Of the 270 children, 55.9% were male, 63.7% were white, and 55.6 were of the upper socioeconomic level. There were 52 2-year-olds (19.3% of the total), 66 3-year-olds (24.4%), 75 4-year-olds (27.8%), and 77 5-year-olds (28.5%).

The findings are presented in three sections: group performance, performances on individual tasks, and analysis of assumptions for the tasks.

The findings for group performance:

1. There was an almost steady decrease in refusals to participate with increasing age. Refusals were more often made by male and white upper socioeconomic children.

2. Success was highly related to age--the older the child, the more likelihood of success. Chi square values for age by year and by half year were significant at the .001 level for all tasks except for the Short Ball Roll and the Long Ball Roll which were significant at .01 and .05 respectively for children in the half year groupings.

3. Success was related to ethnic group membership at varying degrees of probability with the Long Ball Roll (Task VI) showing difference in the direction of black children. Only one task, Task III Serpentine Walk, was found related to socioeconomic level (.01). No relationship was found to be associated with sex.

4. Although the younger children did less well on the tasks, (16% of total successful performances), on only one task (Task V Balance Board Walk) were they totally unsuccessful. Their successes ranged from 9% to 30% on the other tasks.

5. Although male, white, and upper socioeconomic children were more successful, with increasing age the ratio for each group moved closer together. When comparisons were made by instructional mode, the same differences prevailed; however, female performance was somewhat closer to male performance on the "only verbal instruction" tasks (Body Image Tasks I and II). Black males outperformed black females and white females outperformed white males. The upper socioeconomic groups performed better on the "only verbal instruction" tasks. When ethnic groups were compared by sex and socioeconomic factors, the black children were more successful as a group as were black upper socioeconomic and white lower socioeconomic and white lower socioeconomic children.

6. The variables of height and weight, often neglected in research

with young children, was analyzed for relationship to task performance. These were found to be most significantly related to performance in the following order: above average weight (all tasks at the .001 level), below average height (5 tasks at .001), and below average weight (3 tasks at .001 level and two at .01). A higher relationship to performance was found for the tall/heavy and the short/light children. The tall children outperformed the short children on all tasks.

Analyses of the tasks individually resulted in the following findings:

Task I: Body Image Big. Two optimum movement patterns were hypothesized; success by these standards increased with age from 1.9% at age 2 to 24.7% at age 5. The expected movement of full stretch of arms and legs appeared at age 4.0. Arching of the chest with no other body movement began at age 2½ and peaked at age 4.0 when the body configuration began to be increased by movement of arms or legs or both. An increasing percentage of 4- and 5-year-olds used the chest movement to show body bigness. No major difference was found between sexes, ethnic or socioeconomic groups, although black and upper socioeconomic children made the arching of the chest movement most often.

Task II: Body Image Small. Three optimum movement patterns were hypothesized; success by these standards increased with age from 1.9% at age 2 to 29.9% at age 5. Arms placed near or tight to the body and legs folded to buttocks were the most frequent movements to express body smallness. White and lower socioeconomic children most often moved both arms and legs, 3- and 4-year-olds moved arms only, and 4- and 5-year-olds moved legs only. Curling of the body appeared to be a behavior of older children.

Task III: Serpentine Walk. Two walk patterns were hypothesized as

optimum for this task; by these standards success increased from 1.9% at age 2 to 84.4% at age 5. Children were more successful on this task than on any other. More older children (age 4 and 5) made a swivel turn prior to returning to the starting point. Two-year-olds tended to walk across the Serpentine Walk, stepping on 1-3 blocks in the middle and at the marked end; they might or might not return to the starting block following a similar pattern. The 3-year-olds, female, and lower socioeconomic children walked across the Serpentine Walk, stepping on the beginning, middle, and end blocks (practically a straight line), and then returned in practically the same route. Three- and 4-year-olds tended to step on all blocks consecutively from 1 through 12, step off the last block, and stop. A greater proportion of male and upper socioeconomic children were successful; no ethnic difference was found on success. The greatest number of children used the alternating foot stride (61%), used their arms for balance (75%), and slipped, stumbled, or stepped off the blocks (43%). The combination of alternate stride and arms raised to a position other than diagonal for balance was used by 21% of the children.

Task IV: Building a Stepping-Stone Walk. One method of solving this task was predetermined as optimum. Based on this standard, there was a steady increase in success from 1.5% at age 3 to 20.8% at age 5. This task was refused by more 3- and 4-year-olds than any other task. The problem in this task called for the child to balance himself on two stepping-stone blocks as he moved the third or "free" block ahead to become the next stepping-stone. Half of the children attempting the task received the idea of walking on the 3 pattern blocks (most were 2- and 3-year-olds) or on the pattern blocks and the goal block (this behavior

peaked at 3½). More males than females solved Task V in these manners. Movement of the "free" block began at age 3.0 and increased steadily with increasing age. As hypothesized, the staggered, spaced placement of blocks was the solution made by the older children although about 25% of the 5-year-olds did not remember the positioning for the "free" block. Females were slightly more successful in performing the staggered, spaced solution; female, white, and lower socioeconomic children were the most successful groups in moving the criterion number of 5 blocks into correct position. Males most often used two movements of both body and feet while females most often used the alternate foot movement and two body movements. Age and sex differences were found in hand movements--the females pushed blocks along the floor (2-hand pickup) but the males and older children picked up the clocks (2 hands) and moved them around to the side into position.

TaskV: Balance Board Walk. The optimum movement for this task was placement of the feet heel-to-toe for the full length of the board. This task had no successes among the younger children but there were 8.0% successful at age 4 and 18.2% at age 5. The greatest number of children took only 2-3 steps heel-to-toe (behavior began at age 3 and there were almost equal numbers for each succeeding year)--most often these were taken at the start and at the end of the task. This was more a male than a female behavior. Almost identical numbers of 4- and 5-year-olds were nearly successful (missed only 1-3 steps heel-to-toe) or took only 2-3 steps heel-to-toe. Slightly more female and upper socioeconomic children achieved near success. White children were twice an successful, and female and lower socioeconomic children slightly more successful on Task V. Analyses of the behaviors of the unsuccessful children showed that they used 3 major patterns of foot

movement: walking along the stripe (40%), stepping on the toe of their shoe (19%), or placing the alternate foot off the stripe (18%). Almost half of all the children (46%) held their arms close to the body while doing this task. Comparison between Task III and V showed that 45.1% of the children used the same arm movements for both tasks.

Task VI: Ball Roll. Success for this task originally was established as 3 balls out of 3 rolled into the hole; however, as no 5-year-olds in the 1972 study achieved this criterion, the score was revised downward to 2 out of 3 rolls. This task had the fewest successes of the six--4.5% at age 3 to 7.9% at age 5. It also had the fewest refusing the participate--those refusing were mainly white, upper socioeconomic females. This task consisted of 3 parts--practice (3 ball rolls), Short Ball Roll (3 ball rolls), and Long Ball Roll or criterion (3 ball rolls). A steady increase in accuracy for the two ball rolls was found with increasing age--at all ages children were able to place the ball in the hole once or even twice. However, it was not until 3½ that any child was successful on either the Short or the Long Ball Roll. On the Long Ball Roll, black children (male 70%, female 67%), lower socioeconomic males (70%), and upper socioeconomic females (67%) were the most successful. On the Short Ball Roll, the white female (67%), the lower socioeconomic male (59%), the white male (56%), and the upper socioeconomic female (56%) were the most successful. Black children were superior in placing 1 or 2 balls into the hole and equally as successful as white children in placing 3 in the hole. Analyses of placement of the ball on the target board showed that over half of the children rolled the ball too hard on each roll for both the Short and Long Ball Roll. On the long rolls, the most children rolled either too

hard or too short. Only 5 of the 80 crosstabulations of the relationship of the palcement of the last criterion roll to the first or second were at either the .01 or .05 level of significance.

The analysis of the assumptions showed that all tasks devised were indeed psychomotor problem-solving tasks. The tasks presented a wide range of difficulty for the preschool children to whom they were administered. Analyses of gross movements as well as movement patterns used in the solution for each of the six tasks supported the assumption of the problem-solving nature of each task. The children manipulated the data in a number of identifiable and different patterns. Differences were found for age, sex, ethnic and socioeconomic backgrounds. Piaget's theory of development was related in a number of ways to the performance of the children on the tasks: assimilation, accommodation, preoperational figurative cognition, classification, centration, and verbal communication.

Only one task could be scaled--Task III the Serpentine Walk.

Four tasks presenting a configuration to be conserved were successfully completed by a varying number of older children (age 4 and 5). Included in this category should be the Short Ball Roll rather than the Long Ball Roll which is a task of compensation or accommodation rather than conservation.

From the data presented it seems appropriate to draw the following conclusions:

1. The tasks devised met the criteria for psychomotor problem-solving: a wide variety of observable gross movements, sequential patterns of solutions, and relationships to Piaget's concept of development.

2. The tasks, with one exception, were too difficult for success by 75% of the 5-year-olds in the samples.

3. Children at age 4 and 5 begin to conserve configurations in psychomotor problem-solving tasks.

4. Preoperational development and psychomotor problem-solving development are closely related.

It is recommended that research in psychomotor problem-solving be continued and that data be collected from samples representing all sections of the United States. The effect of male testers, both familiar and unfamiliar to the children, should be studied. Comparisons should also be made between the children in the different types of preschool programs--Piagetian, Child-Development Oriented Nursery School, Montessori, Enrichment programs, and the like. A rewarding aspect of research would be the development of individual profiles for the set of tasks to be used for comparison of stages of development with regard to different areas of functioning.

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APPENDIX A

DIRECTIONS FOR RESEARCH ASSISTANTS, REVISED 1973

INSTRUCTIONS FOR RESEARCH ASSISTANTS

Sequential Psychomotor Development of Preschool Children Project

I. Background for the study

There are few who will dispute the tenet that human development is a continuous, ongoing process consisting of observable phases or steps; that individuals proceed through each stage in a regular, continuous sequence of increasing complexity. According to Piaget, young children (age 2-7) have a pattern of behavior arising out of the integration of simpler units into a more complex whole. This pattern or schema is modified by the process of accommodation when coping with new information or new situations.

Studies have been made of how proficient children of varying ages are at specific motor tasks, of how motor skills are best learned, and how motor skills are best taught. Little is known about how children attack (accommodate) motor problems that present a "new situation" to them--how they pattern their movements after being shown a model to copy. This exploratory study is an attempt to answer the question: When preschool children between the ages of 2 and 6 are given a presumably new motor task to solve, what gross motor movements occur among individuals (a) in successes and (b) in failures? In other words,

1. What specific gross body movements are used to solve selected motor tasks of balance at different ages? Do boys differ from girls in kinds of movements made to solve a selected task?
2. What patterns of gross movements are used most often by those children solving the selected motor tasks? By

those children not solving the selected motor tasks?

3. How do children of varying ages differ in motor expression of a verbal idea such as "make yourself as big as you can"?

II. General Procedure

1. The project director, or someone assigned by the director, will make all arrangements for testing. A preliminary visit will be made to each preschool (1) to explain the purpose of the study, (2) to arrange times for testing, (3) to arrange for storage of the equipment during the testing period, (4) to arrange for a place where testing can be done without excessive interruption to the preschool program or to the children being tested, and (5) to obtain names, ages, and other information on the children who will be in the study.
2. Research assistants must notify the proper person(s) of any changes in scheduling. This is extremely important for keeping obligations with the schools.
3. Research assistants will undergo training in testing procedures with the project director before they will be allowed to gather data.
4. The project director and two research assistants will go as a team to each school. The project director will administer all tests to the children. The research assistants will be responsible for observing and recording the performance of each child:
    a. What the child does from the waist up (use of hands, head, trunk, etc.) will be observed and recorded by the assigned research assistant.

b. What the child does with hips, legs, and feet (and the ball on Task VI) will be observed and recorded by the second research assistant.

The research assistants may find it helpful to alternate observations with every other child or with every two or three children.

5. Equipment may be stored at a school where testing will take place over several days. Equipment must be organized before leaving the campus or beginning any testing period. A check list is provided to assist in memory jogging. Equipment must be put in the least possible space when it is not in use.
6. The children will be tested one at a time away from others.
7. Research assistants are responsible for being sure that
   a. each child's name is on each set of records
   b. the testing date appears on the information sheet
   c. the names of both research assistants appear on the information sheet.
8. All testing records will be deposited in the project director's office (226 Stone) as soon as possible after testing.
9. All data are confidential. Names are put on observation sheets only to assist in grouping individuals by demographic variables such as age and sex.
10. Special equipment and procedures have been developed for observing and recording the behaviors of preschool children as they solve selected psychomotor tasks. The problems and tasks, described on the following pages, include:

1. Maintaining balance in forward movement

   . Serpentine Walk (Task III)

   . Balance Board Path (Task IV)

2. Maintaining balance while moving an object other than self

   . Building a Stepping-Stone Walk (Task V)

3. Controlling an object rolled up an incline

   . Ball roll (short target and long target) (Task VI)

4. Expressing body image

   . Body expression of bigness (Task I)

   . Body expression of smallness (Task II)

Carefully study each task described in the pages that follow and the observation sheet for recording the behaviors shown by the children as they attempt the problems. There will be three kinds of observations recorded: (1) observed behaviors that are listed, (2) observed behaviors that are not listed and must be written on the observation form, and (3) refusals. WHENEVER THE OBSERVER FAILS TO RECORD A BEHAVIOR, A "NO RECORD" ENTRY HAS TO BE MADE--"NO RECORDS" ARE COSTLY. IT IS BETTER TO HAVE FEWER COMPLETE OBSERVATIONS THAN TO HAVE A GREAT MANY INCOMPLETE OBSERVATIONS.

11. The test is administered in this order:

    Body Image Big

    Body Image Small

    Serpentine Walk

    Stepping-Stone Path

Balance Board

Ball Roll

When working with the youngest or shyest children, it is often possible to get them interested in the rest of the tasks by switching in mid-testing to the Ball Roll, then proceeding with the tasks in the established order.

III. Training Procedure

1. Attend session scheduled for explanation of the research study.
2. Watch demonstration of administration of test. Study forms. Discuss techniques.
3. Administer test to another college student for practice. The project director will make arrangements for a place to do this.
4. With another research assistant, administer the test to several children individually and record until you feel able to do it with ease. Take time to compare observations. The project director will supply names of children at the nursery school who may be used at this time.
5. Make arrangements with the project director to record observations of the test with a partner. The project director's approval on testing procedure is necessary before research assistants can gather data at the schools.

APPENDIX B

TASK DESCRIPTIONS, REVISED 1973

BODY IMAGE INTERPRETATION
TASK I, TASK II

TASK:

Lying down in face-upward position, indicate by body configuration individual interpretation of big and of small.

Body image big is defined as the body configuration assumed by a subject when asked to make the body as large as possible when lying in a face-upward position. (TASK I)

Body image small is defined as the body configuration assumed by a subject when asked to make the body as small as possible when lying in a face-upward position. (TASK II)

EQUIPMENT:

One sheet of 60 pound Kraft paper.

CONSTANTS:

(a) Subjects will lie face upwards lengthwise of paper at the beginning of each set of instructions.
(b) Some small degree of tugging may be used to help subjects get body into as straight a position as possible.

CRITERION:

At command, subject must change body position sufficiently from the position assumed before the command to be judged as having arranged his body to convey an image of big and/or small.

OBSERVATION:

(a) Stretching or shrinking movements of entire body.
(c) Expansion movements by arms or legs.
(c) Drawing in towards body of arms or legs.
(d) Change of positioning of body: curling to side, sitting up, etc.

END OF ADMINISTRATION OF TASK:

- Observations completed.
- Subject exhibits any behavior that clearly says "I don't understand" or "NO!" to instructions. Instructions will be given two times; children will be asked twice if that is the way they show body size.

SERPENTINE PATH
TASK III

TASK:

To walk a path of approximately 11 feet on wooden blocks placed in a reverse S pattern; to reverse direction on last block in the path and retrace steps to starting point.

EQUIPMENT:

12 wooden blocks 2" x 6" x 8". Marked paper pattern for placement of blocks and for starting point.

CONSTANTS:

(a) Placement of blocks upon marked paper pattern (4' x 6' piece of 60 lb. Kraft paper).
(b) Starting point marked on paper pattern.
(c) Block where turn is to be made is marked clearly.
(d) Subject will be shown how to place foot on three blocks.

CRITERION:

Subject must step on each block consecutively from starting point to end of walk, must turn on or touch foot to last block, and return to starting point.

OBSERVATION:

(a) Upper body movements to maintain balance (Note! Hand in mouth is NOT "arm used for balance." Record as "other.")
(b) Placement of feet during walk
  - Alternating placement (stride)
  - Trailing foot brought to lead foot on same block
  - Missteps
(c) Accuracy of walk
  - Number of blocks stepped on
  - "Short cuts" taken (these must be drawn on diagram)
  - Turn before return
  - End of walk if incomplete

END OF ADMINISTRATION OF TASK:

- Completion of walk both ways (any effort made).
- Completion of walk one way; subject refuses return trip. (If subject remains near path, encourage him <u>once</u> to finish).
- Subject refuses task after instructions given two times.
- Subject refuses task by going away from test area or exhibiting any behavior that clearly says "NO!".

BUILDING A STEPPING-STONE WALK
TASK IV

TASK:

Using three blocks, build a staggered stepping-stone path by (1) taking three steps on blocks spaced in alternate foot walking pattern; (2) keeping one foot on each of two blocks, move the "free" block forward so it becomes the next stepping-stone staggered in line; (3) step to the newly placed block with one foot; and (4) continue steps 2 and 3 until end of path is reached.

EQUIPMENT:

3 wooden blocks 2" x 6" x 8"
1 "goal" object (use wooden block with yellow circle)

CONSTANTS:

(a) Beginning placement of blocks, staggered to approximate step pattern lengthwise (adjustment made for stride of subject). Each subject will complete the same pattern for the first 3 steps.
(b) Demonstration of taking first three steps and of moving two blocks into the forward position.
(c) Marked block placed into position as "goal" for end of walk--at least 4 feet from 3rd block.

CRITERION:

Subject builds a pathway of blocks by moving 5 blocks consecutively to become stepping stones in an alternate-step pattern; and should step using alternate feet on each succeeding block as the building progresses.

OBSERVATION:

(a) Upper body movements
  . Body position as blocks are moved
  . If hand is used for balance
  . How hand is used to handle blocks
(b) Lower body movements
  . How blocks are moved around body
  . Foot movement from one block to another
(c) Accuracy of walk
  . Number of blocks moved
  . Block movement pattern (task solution) THIS MUST BE RECORDED

END OF ADMINISTRATION OF TASK:

. Movement of 5 blocks (any effort made).
. Subject starts task; gets discouraged; will not complete task after being encouraged one time to finish.
. Subject does something other than task after instructions given two times.
. Subject refuses task by going away from test area or exhibiting any behavior that clearly says "NO!".

BALANCE BOARD WALK
TASK V

TASK:

To walk heel-to-toe for 8 feet on a line centered widthwise of a 2" x 8" board.

EQUIPMENT:

One board 2" x 8" x 8' that has a 1½" black stripe centered widthwise for the length of the board.

CONSTANTS:

(a) Demonstration on floor of how to place feet heel-to-toe.
(b) Practice by child on floor prior to walking on the board.

CRITERION:

Subject must walk heel-to-toe the entire length of the board.

OBSERVATION:

(a) Upper body movements to maintain balance (Note: Hand in mouth is NOT "arm used for balance." Record as "other.")
(b) Placement of feet during walk
(c) Relative amount of heel-to-toe placement

END OF ADMINISTRATION OF TASK:

- Completion of walk (any effort made).
- Subject does something other than task after instructions given two times.
- Subject refuses task by going away from test area or showing any behavior that clearly says "NO!".

BALL ROLL
TASK VI

TASK:

Adjusting ball roll for target position from close to far.

EQUIPMENT:

2 inclined, 3-wall wooden boxes; one edge flush with floor.

(a) Target A is 36" from floor edge, centered widthwise on 28" x 60" board with 2" walls

(b) Target B is 60" from floor edge, centered widthwise on 28" x 72" board with 2" walls; a black line is placed widthwise 30" from the floor

1 child-size chair, stool, or other seating arrangement

CONSTANTS:

(a) Angle of incline (at 72" from floor edge, the board is 12" from the floor)

(b) Size of target hole is 6" and a yellow circle 6" in width surrounds the hole

(c) Each subject will be seated with toes touching the edge of the board for the task

(d) Each subject will start with shorter board

(e) Each subject will be shown how to roll the ball on the short board and will be allowed 3 practice rolls

CRITERION

Subject must roll at least 2 balls into the hole in the farthest target.

OBSERVATION:

(a) Upper body movements (especially hand and arm)

(b) Accuracy of ball roll

- Number of times put into hole
- Location of ball at height of roll

END OF ADMINISTRATION OF TASK

- Completion of 9th ball roll (any effort made).
- Subject does something other than task after instructions given two times.
- Subject refuses task by going away from test area or showing any behavior that clearly says "NO!".

APPENDIX C

REVISED TASK INSTRUCTIONS (1973)

TASK OBSERVATION SHEETS

REVISED TASK INSTRUCTIONS FOR CHILDREN (1973)

BODY IMAGE (TASK I, TASK II)

Lie down on your back on the paper.

Make yourself as big as you can.
Is that as big as you can make yourself?

Make yourself as small as you can.
Is that as small as you can make yourself?

SERPENTINE WALK (TASK III)

Watch where I place my feet. (Step on blocks 1, 2, and 3)

Now you do the same thing.
Walk all the way to the end of the blocks.
Turn around at the block with the yellow circle
and walk all the way back to me.

BALANCE BOARD WALK (TASK IV)

(Show 3 steps on floor; have child practice on floor)

Do you know how to walk in a straight line and put the heel of one foot in front of the toe of the other foot? See how I do it. (Take 3 steps)
Touch your heel to your toe each time you step.

Now you try it. (Have child try until he does fairly well)

Now, you walk on the black line all the way to the end of the board. Be sure you touch your heel to your toe each time you step.

STEPPING STONE WALK (TASK V)

When you walk, you put one foot down like this (show slowly)
Then the other foot on the other side (show slowly)
And then this foot back on this side (show slowly)

I am going to build a walk with these 3 blocks.
Now, watch what I do. I walk on this block, then
on this block, then on this one.

Now, there are no more blocks to step on so I need
to get the block behind me and put it in front
of me on this side to put this foot on.

Now, I need another block for this foot so I turn
and get the block behind me and put it on this
side for this foot to step on.

Now, you do just what you saw me do.
(Put blocks back into original position)

Make a walk to the block with the yellow circle on it.

BALL ROLL (TASK VI SHORT, TASK VI LONG)

(Sit on chair or stool and roll ball)

See how I roll the ball and try to get it in the hole?

Now, you sit on the chair.
Place your toes so they just touch the edge of the board.
Try to roll the ball into the hole.
(Allow 3 practice--then 3 counted tries)

Let's move the chair and see if you can roll the ball
into the hole of this other board.
(Toes at edge of board)
(3 counted tries)

BODY IMAGE OBSERVATION

DIRECTIONS: Check all behaviors that apply.

BIGNESS OF BODY (TASK I)

POSITION: ON BACK

Arms

____1 Stretched above head or spread horizontally
____2 Moved slightly away from body
____0 Not moved

Chest

____1 Arched

Legs

____1 Stretched lengthwise
____2 Spread as wide as possible
____3 Moved outward about half of possible
____4 Moved slightly apart
____0 Not moved

Miscellaneous

____0 No visible position change after command
____1 Other movements (briefly describe)

____4 No record

____9 Refused task

SMALLNESS OF BODY (TASK II)

POSITION: ON BACK

Back

____1 Only back touches surface (body curled, head and knees toward chest)

Arms

____1 Near or tight to body
____2 Folded under head
____0 Not moved

Legs

____1 Folded (feet brought toward buttocks)
____2 Close together or touching
____0 Not moved

SIDE POSITION

____1 Body curled tight
____2 Little visible curl

UPRIGHT POSITION

____1 Sits with arms around legs
____2 Sits up

Miscellaneous

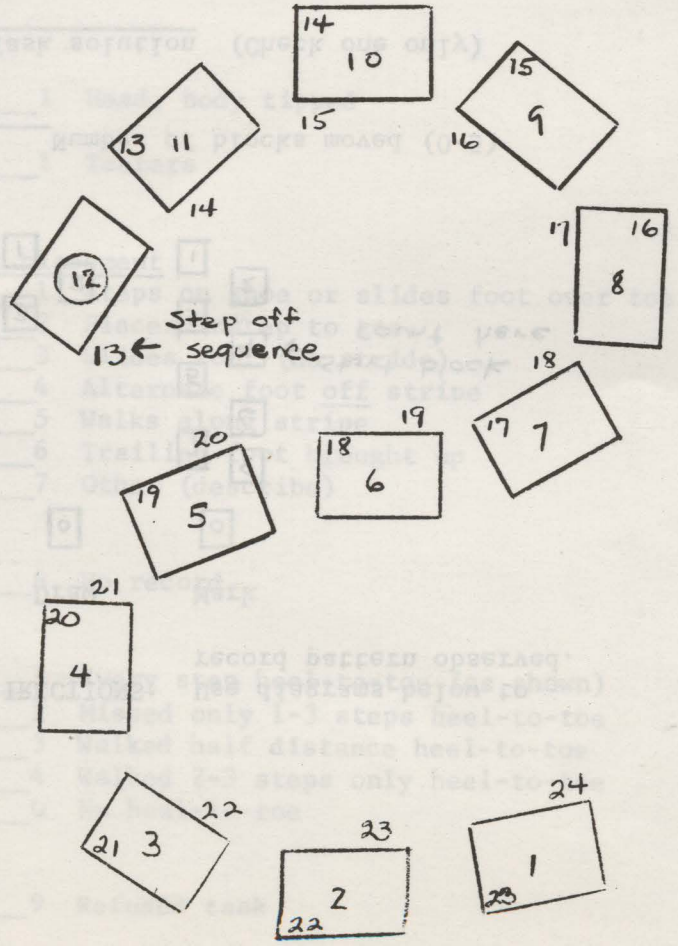
____0 No visible position change after command
____1 Other movements (briefly describe)

____4 No record

____9 Refused task

Directions: Mark where subject steps off, slips, turns, etc.

Circle number for last block completed. Note that there are 2 sequences for return journey.



____Total number of blocks stepped on (0-23/24)

SERPENTINE WALK (TASK III)

Directions: Check all behaviors that apply

Upper body movement

____1 Hands remain close to body
____2 Arm(s) raised or used for balance in position other than diagonal
____3 Diagonal use of both arms
____4 Diagonal use of one arm
____5 No record
____6 Other (briefly describe)

____1 Head, body tipped

Foot movement

____1 Alternate foot stride
____2 Trailing foot brought up
____3 Alternate AND trailing foot used
____4 No record

____1 Slips, stumbles, steps off block

Walk pattern

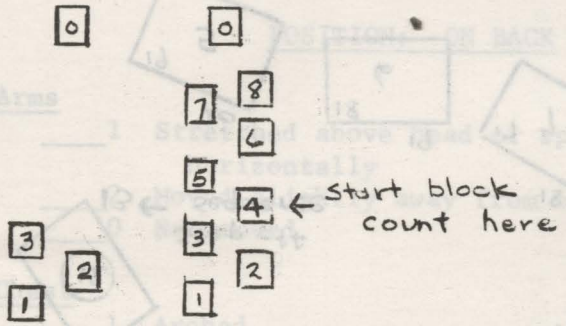
____1 Touches #12, turns; returns on path to #1
____2 Turns at/on #12; returns on path to #1
____3 Walks 1-12; crosses to 19/20; continues to #1
____4 Walks 1-12; ends
____5 Begins 1 - 4/5/6 - 12/13 (remainder erratic)
____6 Walks 1 -4/5/6 - 12/13 - 16/17 - 1
____7 Erratic (MUST BE DRAWN)

____8 No record

____9 Refused task

DIRECTIONS: Use diagrams below to record pattern observed.

Draw Mark



____Number of blocks moved (0-5)

Task solution (Check one only)

____1 Staggered walk (spaced; first block placed to right)
____2 "Pattern" reproduced, spaced (1st block to left)
____3 "Pattern" reproduced, tight (1st block to left)
____4 Straight or diagonal, spaced (1st block above #3)
____5 Straight or diagonal, tight (1st block above #3)
____6 No discernable pattern formed
____7 Walked "pattern" blocks and "goal"
____8 Walked "pattern" blocks
____9 Other behaviors (briefly describe)

STEPPING STONE WALK (TASK IV)

DIRECTIONS: Check behaviors as they apply.

Body movement/balance (Check all behaviors that apply)
____1 Swivels (smooth rotation of upper body)
____2 Stoops (bends from waist)
____3 Squats (knees bent, buttocks close to floor)
____4 No record

Hand balance
____1 Hand(s) on floor

Hand/block movement
____1 1-hand pickup
____2 2-hand pickup
____3 1-hand AND 2-hand pickup
____4 No record

Block movement
____1 Brings forward between legs
____2 Pushes along floor
____3 Pushes along floor AND brings between legs
____4 No record

Foot movement
____1 Alternate from block to block
____2 Both on one block
____3 Foot or feet on floor
____4 No record

____9 Refused task

BALANCE BOARD WALK (TASK V)

Upper body movement

____1 Hands remain close to body
____2 Arm(s) raised or used for balance in position other than diagonal
____3 Diagonal use of both arms
____4 Diagonal use of one arm
____5 No record
____6 Other (briefly describe)

____1 Head, body tipped

____1 Teeters

Foot placement

____1 Steps on shoe or slides foot over toe
____2 Places instep to toe
____3 Slides foot (no stride)
____4 Alternate foot off stripe
____5 Walks along stripe
____6 Trailing foot brought up
____7 Other (describe)

____8 No record

____1 Every step heel-to-toe (as shown)
____2 Missed only 1-3 steps heel-to-toe
____3 Walked half distance heel-to-toe
____4 Walked 2-3 steps only heel-to-toe
____0 No heel-to-toe

____9 Refused task

BALL ROLL OBSERVATION (TASK VI)

Accuracy of Ball Roll

Directions: Mark highest roll of ball (except whenever ball goes in hole) for each trial

		Short Roll			Long Roll		
Roll of Ball		1	2	3	1	2	3
Bounces off board	1						
Top half, no color	2						
Top half, yellow	3						
IN HOLE	4						
Bottom half, yellow	5						
Bottom half, no color	6						
Below 30 inches	7	X	X	X			
No roll	8						
REFUSED TASK	9						
No record	4						

Hand movement (Check all that apply)

____1 Underhand
____2 Sidehand
____3 Toss
____4 Other (briefly describe)

____5 No record

Body movement other than sitting

____1 Stands
____2 Climbs board
____3 Other (briefly describe)

____5 No record